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CIVIL ENGINEERING.

*On the Decay and Preservation of Building Materials.** By Prof. D. T. Ansted, M.A., F.R.S.

(Continued from page 163.)

The question then arises how these things are to be overcome in our climate. Generally speaking, one would be apt to suppose that non-absorbency was a most desirable thing; and that if we could render stones non-absorbent—that is, if we could prevent them from sucking in the moisture and these dangerous gases—we should be able to answer our purpose and prevent the decay of the stone. I need not inform you that it is no new thing to preserve in this way—not, indeed, stone—but other substances, such as stucco and terra cotta. You can scarcely go into a good modern street in London without seeing a large number of houses covered over with cement, and that cement covered over with paint. Now, what is paint? It is a mixture of oil and oxide of lead. The paint coats the surface in such a way that water cannot get into it. We all know the result; the paint, indeed, never looks well; it is not an ornamental thing under ordinary circumstances, and much less so when applied to stones. But how far is it successful? Why, the moment it is put on, it begins to decay. Decay must take place, because oil begins to decompose the moment it is exposed to the action of the air; and the result is, that after a very short time the oil separates from the oxide of lead, and the surface first blackens

* From the Journal of the Society of Arts, No. 396.

and soon begins to peel off. You have a thin film of oil and white lead put on a surface; it adheres slightly for a time, but the moment it is left alone it begins to decompose and rot, and in the course of a year or two you must do all the work over again. Numerous plans have been patented for coating and choking the pores of absorbent stones with preparations of various kinds. The almost invariable idea has been, to render the stones as far as possible non-absorbent. This has been done by combining a certain proportion of mineral substance with oil or fatty matters. There is but one observation with regard to these; they all inevitably tend to decomposition except, perhaps, those that are of a pitchy or bituminous nature.

Bitumen is of a nature that does not decompose by exposure, and is permanent, but it is of so dark and disagreeable a color that it completely destroys the appearance of stone, and renders it so unsightly that no one could venture to recommend it. Oil and fatty substances, therefore, are the only ones that have been used. One cannot help feeling, that if our stone buildings are to be painted till their character as stone is lost, it would be better to build them of cheaper material and use bricks and stucco at once. I may say with regard to the patents that have been taken out within the last 20 years on subjects of this kind, that I have had no less than 17 before me, and out of these 17, 11 are simply mixtures of various substances with oils and resins, and are therefore essentially of the same nature. Some of the others use mixtures of mineral matters in oil, but none of them appear to have answered the purpose, and none of them are now employed at all. There is another point I ought to mention, and that is, that a mere mixture of things not involving chemical combination, must fail. We must then either have some invention by which the pores of stones are permanently choked by a bituminous substance, not unsightly, and not in any way subject to decomposition, or we must find some mineral deposit which we can answer for, which will adhere firmly and which will also be permanent; in other words, we must put something into or upon the stone which shall be a mineral substance, closely adhering and not subject to ordinary atmospheric influences.

It is now many years since a suggestion was made by a French chemist, of the name of Kuhlman, which was apparently very ingenious, and which to a certain extent, answered the purpose. It was a suggestion to coat the surface of absorbent stones with silica. Now, I have already spoken to you of silica as forming the great mass of sandstones, and also, to a great extent, the base of granite. Common flint is the form in which we all know it. In that form it appears to be rather an unpromising suggestion to apply it to a surface in such a way that it shall adhere and be permanent. Silica, which is in fact a combination of a base which is called *silicon* with oxygen, is also called by chemists *silicic acid*, but the acid properties are so weak that they cannot be recognised by the senses, and its affinities for alkaline bases are very feeble. Silicic acid, or silica, is capable of existing in combination with water, and in combination with some alkalies is soluble; is found in nature, combined with water, in some minerals, and

when in that state is passed into a state of insolubility by the action of alkaline carbonates, among the rest carbonate of lime.

As a natural hydrate, or combined with a small quantity of water (about 3 or 4 per cent.), it forms part of some particular kinds of sandstone. It is also found in natural hot springs, and even in common spring water,—no doubt by the action of carbonic acid. I have said that it is soluble in caustic alkali. It is soluble, for example, in caustic potash and caustic soda, not under ordinary temperature and pressure, but at a temperature of 300° or 400° F., and under steam pressure. Under these circumstances there is no difficulty in dissolving it. You get a solution in this way: a mixture of silica and potash combined with water, and a tenaceous though soluble fluid. I have a specimen of it before me. You see it is perfectly fluid; it is as much a fluid as water would be; but if in this state you expose it to the action of ordinary air for a time, it hardens, becoming first sticky and gelatinous. It is then a hydrate of silica. To become this it undergoes a certain kind of decomposition, parting with its potash to carbonic acid in the air. Before the lecture, I placed a drop of the fluid solution on a piece of glass, and those who take an interest in it may see what the effect has been. It was perfectly fluid; it is now quite gelatinous and sticky, and in a short time it will become perfectly hard. It has attached itself, also, firmly to the surface of the glass, and could not now be removed. In this form it was proposed to use the liquid silicate of potash, or water glass, by M. Kuhlman, whose process consists in the coating of absorbent stone with the solution in question, and he believed that after this treatment the stone would become coated with silica. Since it is known that silica laid on and dried is insoluble, he believed he had secured a useful result; but he forgot that insoluble silica that has been deposited in that way is still capable of being acted upon by the alkaline carbonates. Therefore, even when thus deposited, still in the course of time the alkaline carbonates of the atmosphere would act upon it, and it would be a failure. But that is not all; for, if at the time I put this drop on the glass I had not taken care that the glass was dry, or if I had dashed water on it, it would have been washed away. Now that is exactly what would happen if you put some of it on a stone, and a shower of rain were to fall. In that case the effect would be destroyed, the preparation being washed away. So much for the process which Kuhlman invented. It is right to say that M. Kuhlman himself believed that when used in limestone a double decomposition would take place, the silicate of potash being not only decomposed by the carbonic acid of the air, but a part of the silicic acid combining with the lime to form silicate of lime. This would, however, be a work of time, which the weather in a damp climate would not permit.

Another process has been introduced by Mr. Ransome. His plan was to decompose the silicate of potash and to produce a deposit of mineral upon it, which would adhere to the stone by a process of double decomposition. He considered that if a mineral deposit could be absorbed into the stone, I mean if, after a solution was absorbed into the

stone, it could afterwards, by a chemical combination caused by another solution subsequently absorbed, be decomposed so that a solid film would be everywhere deposited, and if this could be done in a very brief space of time, so that damp air, and rain should have no effect upon it, then the object required would be attained. It suggested itself to him in this way:—He was in the habit of manufacturing the soluble silicate on a large scale, and he thought that by combining it with the chloride of calcium (muriate of lime) he would get this double decomposition. This is the case, because soda and potash have but a weak affinity for silica, and lime a very strong one. Silica, therefore, parts very readily indeed with soda or potash to lime, whilst the chlorine would, with great readiness, pass to the soda. He therefore attempted the process; and I think you will say he attempted it with some success, at any rate so far as the experiment went. There is, however, no obscurity about the general result, as it is simply a matter of experiment. The first thing he did was to satisfy himself that he could get a rapid deposit. In the two glasses before me, one contains a certain proportion of silicate, and the other contains a corresponding proportion of the chloride of calcium, so that the two shall combine and form solids. In mixing these together, I put the chloride of calcium into the silicate of soda. The result is, that the affinity of the chlorine for sodium being greater than that for calcium, while the affinity of the silica for soda is weak, a double decomposition takes place, the chlorine leaving the calcium to pass to the sodium, thereby forming soluble chloride of sodium, or common salt, and the silica and lime set free, also combine to form silicate of lime, an insoluble salt, which is immediately thrown down in a solid state. The proportions being properly taken, the whole of the water is taken up and made use of as water of solidification, and the salt can be subsequently removed by washing.

[The lecturer, while performing the experiment, stated that by the time the lecture was over the whole of the contents of the glasses then liquid would be in a solid state, and added, that unless it was removed before long, the solid silicate of lime formed would adhere to the glass so firmly that it would be very difficult to get it off.]

We thus have silicate of lime rapidly formed, and being obtained in this way it is necessary to consider what the result would be in the solution of the problem before us. I need not say it is by no means sufficient to have an insoluble mineral deposit placed on the surface of a mineral whether calcareous or silicious. It is not only necessary to have that, since there must also be cohesion, and this cohesion must be sufficiently powerful to render the mineral coating preservative. It is absolutely necessary that the silicate of lime should be a material which, when put on a surface of stone, should not only remain there, but become permanently adherent. Experience, however, has long ago shown that a very thin deposit of this peculiar mineral, silicate of lime, does adhere with singular rapidity, and with the most remarkable tenacity, to particles of sand and stone with which it comes in contact. It is the film which, produced gradually, gives all its value to mortar, and which cements together the stones of which are formed what build-

ers call concrete, on the very existence of which as a firm solid mass, half our buildings depend. Immediately on the deposit of the minute particles produced by the double decomposition of two minerals and formation of two others, this strong tendency to adhere comes into operation. The particles of silicate of lime newly set free, immediately and firmly attach themselves to the particles or grains of which the stone is made up, not only surrounding them, but binding them to each other, just as when mortar has long been left to harden it is as difficult to separate the parts cemented as it is the solid brick or stone; this it is which gives its principle value to the method suggested.

I have laid on the table several specimens of different materials which have been treated in this way, and also some of the results after they have been exposed to decomposing agencies. Near me are two specimens of terra cotta. One has not been treated in any way, and it is exceedingly absorbent, and we know from experience that terra cotta soon becomes injured on exposure to the weather. The other has been treated by the processes that I have mentioned, and if any one will take the trouble to scratch the surface, he will at once see the nature of the change. The surface has become excessively hard, and although when treated this way it is not necessarily non-absorbent, it can be made so by repeating the process often enough. If not made non-absorbent, however, it has become less capable of injury by exposure. These specimens were prepared at the Museum at South Kensington.

There is also before me a specimen of Heddington stone exposed to Ransome's process, and another specimen of the same stone not exposed to that process. Both of them have been dipped in acid, and the result is as you see. The surface of one is entirely gone; the surface of the other is not touched. There are also two specimens of Caen stone, one exposed to the process and the other not. Both have been subjected to the same amount of acid, and the result is that one stone is entirely destroyed and the other is not injured. There are several other specimens of Mr. Ransome's stones on the table, and the hardness of them will be at once recognised by any one who will compare them with similar stones not so treated.

There is another process which I ought to mention, which has been partly carried into operation in the Houses of Parliament. It was introduced by a Hungarian gentleman, of the name of Szerelmey.* I

* Since the lecture was delivered a correspondence has been printed by order of the House of Commons which renders some further observations desirable:—Mr. Szerelmey had not, I now find, allowed me to ascertain the real nature of the method he adopted, which consists in the use of soluble alkaline silicates, succeeded by a wash of bituminous matter also in solution. This was stated in confidence to Dr. Faraday, who, however, does not say that the application of the soluble silicates is succeeded by a second wash producing a deposit of silicate of lime. We are led to infer that the second wash is the bitumen only, and the object of this must be to shelter the surface while the alkaline silicate is undergoing slow decomposition and becoming converted either into hydrate of silica or silicate of lime, just as by Kuhlman's method. It would thus appear to be Kuhlman's process with the addition of a bituminous and temporary sheltering surface. It still remains to determine whether by this process permanent protection is given, as if the deposit consists of hydrate of silica, the alkaline carbonates to which it must soon be exposed will no doubt destroy it. The temporary shelter of bitumen cannot be taken into account as having permanent value, although, for the time it lasts, it may, no doubt, appear to be more efficacious than any thing else. I observe that Dr. Faraday, in expressing a qualified opinion on the present appearance of the stone thus acted on, speaks "of the short and insufficient evidence now existing." It is indeed clear that the real value of the method of Kuhlman depends on the nature of the deposit formed, and I believe it has not yet been determined what this is, simply because there has not been time enough given for the experiment. Complete exposure of a surface protected by Mr. Szerelmey left without any subsequent treatment for some years (four at least), could alone decide the question. The condition of the Speaker's Court, in the Houses of Parliament, will thus after a time be a fair test of the value of his method.—D. T. Ansted.—20th May, 1860.

can hardly with propriety say any thing about it. I know too much and too little about it to be able to express an opinion. At the same time, if I did not mention it, it might seem as if I had not been aware of it. Mr. Szerelmey, at the suggestion, I believe, of the late Sir Charles Barry, asked me to look at his process, but he did not inform me what its preservative power consisted of, and although he intimated its nature, he evidently intended me to regard what I observed as confidential. All I can say is, that regarding it as a secret process, it is quite impossible for any one to express an unqualified opinion of its value until time shall have tested its capabilities. It is, therefore, best not to speak of it at all until it has been exposed for a number of years to the action of the weather. Time alone can show what its value is, if the materials employed are not stated, and certainly an experience of not less than several years can be regarded as of any value, since ordinary paint or drying oil will preserve absorbent stones for that period.

In returning now to the original subject, let me remind you that if, as seems to be the case, we are forced to make use of soft, perishable material for purposes of decorative work in architecture, if we are obliged to accept the material that nature has provided near at hand, and select from varieties which differ indeed much in durability but all of which decay, it would seem only reasonable that due precaution should be observed to take for the best work the most favorable varieties of stone, and use great caution in rejecting manifestly bad or indifferently good samples. That this can be done every quarry-man and every stone-mason well knows, and there are means of determining the good from the bad which are independent of their experience. Where enormous sums are to be expended on decorations for a permanent building, it is surely not unreasonable to expect and require that a little niggardly economy in regard to the material of construction should not be indulged in. But I regret to say that in most modern public buildings it has not been thought necessary either to determine the kind of stone with reference to its probable durability, or to appoint a competent person to reject on the spot bad samples. With regard to our architects, it seems hardly to be a part of their education to inquire into and understand such matters, and they do not consider themselves responsible ultimately for the consequences of neglect. I have endeavored to show what must happen when bad stones are placed in a building erected in or very near a large town. The whole of the stone decays, but the more prominent and the more ornamental parts, those on which the effect most depends, and on which most money has been spent, these decay first. Moisture is absorbed, frost comes, and the delicate projecting parts fall. Gases and acids are absorbed together with smoke, and the stone is first blackened and disintegrated, and then reduced to powder. But of course there are bad and good pieces; there are exposed places and sheltered places, and the result of this is that not only does the stone decay, but it decays with the utmost irregularity: adjacent stones become very soon in a state so different that no one could have supposed they were dug from the same quarry, and the whole surface is unsightly and disfigured.

None of the nobleness and beauty of decay is seen in these cases. There is a decent and picturesque appearance, not unfrequently met with, in old buildings which inspires respect instead of dislike. There is the hoary front of age, of which none can complain. It is seen in the marbles of Greece and Asia Minor, in the limestones of Rome, and even in some of the porphyries in Egypt. Time, we are told, devours all things. All human contrivances must submit to it, and as it is a natural, so it is often a beautiful condition. But premature decay, like an artificial ruin, has a poor and mean appearance. It does not give the idea of waning strength, but of absolute innate weakness. It is a *coup manqué*—a thing not merely imperfect, but unnecessarily imperfect.

It is important to remark also that bad stone was not always used. Many of our old buildings have scarcely shown incipient decay—many of those in large towns have decayed so as not to be unsightly. This, it is true, must not be altogether attributed to the material, as such buildings, if erected now with picked stone from the same quarries, would probably injure much sooner, owing to the much larger quantity of impurity in the atmosphere to which they are exposed. When a stone has been for some time exposed to pure air it hardens, and thus buildings, placed where we see them before the large town arose around them, have stood exposure better than they could do now. But there is reason to know that the selection of stone was much more careful formerly than it has been lately, and the result is manifest.

There is one more point. If the method of protection and preservation so ingeniously contrived by Mr. Ransome is successful, as it really seems to be, the softer and cheaper stones may be used. It is certainly the case that a hard, almost flinty surface is obtained by it, and that such surface is not acted upon by the acids which rapidly destroy the same stone when unprotected. For four winters stones thus protected have stood the action of the weather, and if it turn out to be as durable as seems likely, from this and other trials on a large scale, if absorption is checked—so far at least as its injurious effects are concerned—for mere absorption does not seem to be injurious, and if decay is thus arrested, then there are means at hand which cannot fail to have a great influence on decorative stone-work, for the material most easily carved and sculptured is just that one which is most completely improved by the process.

In thus speaking of the decay and preservation of stone, I have endeavored to confine myself strictly to the subject before me, not traveling out of the record. I feel, however, so convinced of its importance that I offer no apology for bringing it before you, and, perhaps, when in your summer ramblings you visit some noble cathedral, or wander over the ruins of some ancient castle or tower of classical or middle age construction, you may feel an interest in examining the cause of the beauty you there see arising from decay, and contrast it with the dissatisfaction and disappointment I am sure you cannot help feeling on examining some of the recent restorations of Westminster Abbey, or the richly decorated surface of the great palace of the nation immediately adjacent.

*Abstract of a Paper on Steam Boilers.** By F. H. SAWYER.

The author, after pointing out the main features of the different varieties of steam boilers, proceeded to a more minute consideration of the marine, as being, in his opinion, the most important. In describing the flue boiler, he remarked that it was quite impossible to give a very accurate account of the proportions of heating surface to fire-grate, &c., as one pair of engines might exert only their nominal horse power, whilst another pair might exert four or five times as much. The author argued the great superiority of the multitubular, as compared with flue boilers, founding his preference on the fact that a boiler of the former kind might be applied with a reduction of sometimes one-third the space, and even a greater proportion of weight, and at the same time giving a greater heating surface per horse power. In exemplification of this he gave the particulars of the original flue boilers of the *Great Western* steam ship, and compared them with the new boilers of the tubular principle, afterwards substituted; the results being as follows:

	Old Boiler.	New Boiler.
Weight with water, . .	280 tons.	108 tons.
Heating surface per H.P., .	9·6 sq. feet.	17·8 sq. feet.
Area of fire-grate, per H.P.,	.5 "	·36 "
Consumption of coal, per H.P. per hour,	8·33 lbs.	5·6 lbs.

The author was of opinion that, by the application of a blast in the funnel, a greater quantity of fuel might be burnt per square foot of fire-bar, and that, therefore, a boiler of smaller dimensions would be attainable; remarking, at the same time, that he considered that, in some cases, the space thus saved would counterbalance the space and value of the extra fuel used. The author then proceeded to discuss the adoption of a higher pressure of steam, together with the principle of surface condensation, noticing that we could not hope for a successful result by jumping at once from 20 lbs. to 50 lbs. per square inch, but he had no doubt that the advantages of a higher pressure would be seen, and that we should see it gradually increasing in the same manner as it had increased from 4 lbs. to 20 lbs., showing a corresponding reduction in the consumption of fuel. He did not expect to see the economy reduced so low as was said to be the case in the *Thetis;* and although he had no doubt but that considerable economy had been attained in that vessel, at the same time he was not prepared to admit or credit the very wonderful economy said to have been realized.

After giving the dimensions and particulars of the tubular boilers of the *Queen* steamer, constructed by Messrs. Rennie, and noticing them as an advantageous description of boiler, the author proceeded to discuss the advisability of brick or iron fire bridges, giving his decided preference to the brick, from the ease with which they can be altered or removed, and also from the fact that the iron bridges so soon wear out, owing to the difficulty the steam has in escaping from the interior, and their great liability to corrosion from the water that might escape from the tubes.

*From the Lond. Engineer, No. 220.

In a boiler of good proportions he considered there should be no priming, but should any take place owing to dirtiness of water, passing from fresh water in salt, or *vice versa*, he recommended the use of tallow, or as a preferable expedient, if circumstances permitted, opening the fire-doors and slackening the fires. He considered, also, that some trouble might be caused by priming in small high-pressure marine boilers, unless great care was exercised.

The author devoted but a small portion of his paper to the consideration of the stationary and locomotive boilers, but occupied some of his remaining time in discussing the relative economy of the Cornish and locomotive boilers, considering the Cornish greatly superior, as in a locomotive the temperature in the smoke-box was notoriously greater than the temperature at the base of the chimney in a Cornish boiler, and that the heat passed up the funnel was a dead loss, except that which was necessary to keep up the draft.

The author concluded by giving the dimensions and mode of construction of one of Stephenson's 12 in. locomotive engines, as also that of Crampton's colossal engine, the Liverpool.—*Proc. Civ. and Mech. Eng. Soc.*

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*The Decay of Timber and its Prevention.** By H. LETHEBY, M.B., M.A., &c., Professor of Chemistry in the College of the London Hospital.

SIR:—I regret that I was not able to be present at the Society of Arts, on the 30th May, during the reading of Mr. Burnell's very valuable paper on the causes of decay in building woods, and the means of preventing it; for, as I have directed much attention to the subject, and especially to the *modus operandi* of creosote, or dead oil, in preserving timber, I should have taken part in the discussion.

Mr. Burnell does not attach too much importance to the process of creosoting timber, when he regards it as the most effective of all the processes known for the prevention of decay; for, in truth, the dead oil of common coal-tar contains all the elements which are necessary for giving permanent stability to organic compounds, by checking decomposition, by opposing the processes of oxidation, and by destroying the vitality of the lower forms of animal and vegetable life. If, indeed, the application of creosote to timber has ever failed in preventing decay, it has been because of the improper use of it, or the use of an oil which has not contained a due proportion of its most effective constituent—carbolic acid. This it is which is chiefly concerned in strengthening the weak affinities of the young or immature constituents of wood. It coagulates the albumen and gives firmness to the cellulose matters that are so prone to decay, and which communicate by a sort of catalytic influence, their decomposition to the neighboring and more mature tissues. So powerful is the antiseptic property of this acid that, when separated from coal tar, it will at once arrest the decomposition of every kind of organic matter. I have seen it stop the putrefactive changes of sewage and cess-pool matter instantly, and it will even stay

* From the Journal of the Society of Arts, No. 395.

the more active decomposition of putrefying animal flesh. It is to be regretted that all samples of dead oil do not contain a like proportion of this valuable constituent. I have found that it ranges from 0·05 per cent. to rather more than 6 per cent. of the oil; and as the value of the oil is dependent on the proportion of this acid, it is a matter of some importance to know how its presence can be discovered. A rough estimate may easily be made by shaking up about half a pint of dead oil with its own bulk of a rather weak solution of caustic potash. After standing for a little while, the oil will separate, and the potash solution of the carbolic acid may be poured off. On acidulating this with sulphuric acid, the carbolic acid will separate, like an oil, and it may be known by its creosote-like odor.

Another important constituent of dead oil is the hydro-carbon, which gradually discolors the oil and thickens it by absorbing atmospheric oxygen and forming a solid pitch. This operates in preserving wood by appropriating the oxygen which may be within its pores, and so checking ligneous eremacausis. The resinoid body which is formed shuts up the pores of the wood and effectually protects it from the action of air and moisture. The presence of this hydro-carbon may be known by the darkening, and, as it were, drying of the oil when it is put upon white filter paper and exposed to the air. In the distillation of the oil this compound comes over most freely at the time when naphthaline distils; and as far as my experiments have gone, I am led to think that the best dead oil (that charged with most carbolic acid, and the resinafiable hydro-carbon) comes over at from 360° to 490° Fahr. The carbolic acid is most abundant in the runnings at or near to the first temperature, and the media for holding them in solution and applying them to the timber at the last. Naphthaline, and paranaphthaline, or salts, as they are sometimes termed, will of course come over at these temperatures; but as these substances are of no value whatever in preserving timber, they should be separated as far as possible by submitting the oil to cold and to the action of time. Dead oil should not be exposed to the air more than is necessary, in order that oxygen may not be absorbed and the oil thickened and discolored. Lastly, I may say that carbolic acid and the hydro-carbons of dead oil are among the most powerful poisons to fungi, and acori, and all the lower forms of organic life. The oil, therefore, acts as a physiological preservative of timber. In point of fact its preservative action is of four kinds:

1. It coagulates albuminous substances, and gives stability to the constituents of the cambium and cellulose of the young wood.

2. It absorbs and appropriates the oxygen which is within the pores of the wood, and so checks, or rather prevents, the eremacausis of the ligneous tissue.

3. It resinifies within the pores of the wood, and in this way shuts out both air and moisture.

4. It acts as a positive poison to the lower forms of animal and vegetable life, and so protects the wood from the attacks of fungi, acori, and other parasites.

No doubt the action of the oil is injurious to higher forms of animal life. It is even offensive to ourselves, and hence the objection to its use in the interior of buildings. But I am led to think that this objection may be overcome by the use of agents, which, like nitric acid in its action on the benzole of the lighter oil of coal tar, may give to the dead oil a less offensive, if not a positively pleasant odor. When this is accomplished there can be no objection to its use in the interior of buildings, or for the preservation of ships.

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*Description of a Steam Crane.** By Mr. J. CAMPBELL EVANS, of Greenwich.

The steam crane described in the present paper was designed more especially for use on board steam vessels; and the chief points to be aimed at were consequently compactness, facility of fixing, simplicity in the mode of working, and durability. In cranes usually constructed, the boiler being separate from the engine, the union joints of the steam pipe are very liable to leak; and the writer believes there are very few such cranes where this circumstance has not been a continual source of trouble and annoyance after a few months' regular work. Frequently the boiler is a considerable distance away from the cylinder, and then the steam and feed pipes are liable to be injured in stowing the cargo; in addition to which, the condensed steam strains the machinery, and keeps the deck of the vessel constantly wet and dirty.

To obviate these disadvantages, in the present steam crane, the boiler is placed as close as possible to the crane, and revolves with it; and by making the top of the boiler of cast iron, with lugs for attaching the tension rods, it serves the double purpose of boiler and crane post. The bed-plate upon which the crane and boiler are placed is fixed to the foundation-plate by a centre bolt, which bears all the upward strain; the downward pressure is taken by rollers, having their bearings in the bed-plate, and running on the foundation-plate, which is solidly bedded on timber laid on the deck of the vessel.

To avoid upright tubes and horizontal tube plates, the heating surface of the boiler is arranged in cones; the first cone or fire-box is exposed to the direct radiation of the fire, after which the heat passes through an opening nearly opposite the fire door into an annular space between the second and third cones, where it is absorbed by the water spaces on either side, and passes round to the funnel opposite. In this way a sufficient heating surface is obtained without any horizontal surfaces in the boiler for deposit to accumulate upon. The two angles or bottoms of the water spaces are below the direct action of the fire, and are connected by pipes to allow for the circulation of the water, provided with plugs and cocks for cleaning. The water tank is placed under the boiler; this position serving to heat the feed water and to preserve the cast iron bed-plate from danger of fracture by the heat of the fire.

The crane is worked by a single oscillating cylinder, supported by

* From Newton's London Journal, August, 1860.

brackets on the bed-plate. The joints for the steam and exhaust pipes at the trunnions are made tight by gun-metal cones, fitted to the trunnions and held by studs in the brackets; when these have become polished by working, the wear upon them is very slight, and this construction has been found very suitable for the rough treatment to which cranes are usually subject. On the crank shaft is a friction wheel, grooved according to Mr. Robertson's plan, and kept continually revolving by the engine. On the second shaft is another friction wheel, which, by means of a lever, can be moved into gear with the driving wheel, or, by an opposite motion of the lever, can be pressed against a brake, or when lowering can be held between the two. The other end of the second shaft carries pinions gearing into wheels on the shaft of the chain barrel. There are two pairs of wheels and pinions, for varying the speed according to the weight to be raised; the pinions are thrown in and out of gear by a sliding key, instead of the ordinary clutch; by which means, the width between the frames that would be required for moving the ordinary clutch is saved.

The writer believes the principal difficulty experienced in steam cranes for ship purposes is in the arrangement of the turning gear; so that when the vessel leans over to one side, the crane shall be powerful enough to swing the weight, and yet not cause a sudden start or shock to break the gear. In this crane, a coned friction clutch is used, to allow a slip at first and to start the weight gradually; and the arrangement of the foundation-plate of the crane admits of a much larger spur-wheel than usual being employed to bring up the power. On the crank shaft is a worm working into a worm wheel, on the shaft of which is a bevil wheel, gearing into the two bevil wheels above and below, which are thus kept constantly revolving by the engine. By means of a coned clutch acting on one or other of these wheels, the crane can be moved round either way, as desired. The two operations of lifting and turning the weight are easily managed by one man.

The valve motion of the oscillating cylinder is designed to compensate for the oscillation of the cylinder without the use of sweeps and guides. A radius rod is centred on the cylinder bracket, and connected to the eccentric rod by a link, to which the valve rod is attached by a pin. The link combines the vibrations of the eccentric rod and radius rod, so that at the point where the valve rod is attached, the curve described by the radius rod compensates for that described by the eccentric rod in such a degree as to bring the valve rod into the curve it would naturally be made to describe by the oscillation of the cylinder.

Mr. Evans observed that the crane was intended as a machine of simple construction, complete in itself, including boiler, for fixing in such situations as on decks of vessels or on quays, where generally the expense of larger stationary boilers for working a number of separate steam cranes could not be gone to. These cranes had worked very satisfactorily, the only wear, after more than a year's work, being in the bearing of the crank shaft, and by tightening up the nuts of the cap one-eighth of a turn, all the wear of some months was taken up.

There was an advantage in the leverage in turning round, and the crane was found very convenient for handling; the grooved friction wheels, for connecting and disconnecting the motions, had proved very satisfactory, and worked smoothly and efficiently.

Mr. H. Maudslay inquired what pressure of steam was used, and what weight could be easily lifted by the crane; and what was the cost of the whole.

Mr. Evans replied, that 30 to 40 lbs. steam was used, and the crane lifted 50 cwts.; a larger size was being constructed to lift 50 cwts. 42 feet high in half a minute. The cost of the cranes at present made was about £200 complete; no pipes were required for connexion to the boiler as in detached steam cranes, and no fixings were wanted for the crane or boiler; all that was required was to lay down 4-inch timbers to bed the frame upon, and it was a particular advantage in the case of ships that no holes were required in the deck for the crane post, the whole being self-contained.

Mr. E. A. Cowper thought it was a disadvantage in the arrangement that the steam must be shut off directly the load was off to prevent the engine running away; and a single cylinder had this disadvantage—that it might stop on the centre, causing a delay in starting the crane again. He thought it was preferable, for working a crane, to have two cylinders working cranks at right angles and with link motion, as in Taylor's steam winch; the engines were then started or reversed readily, in whatever position they might have been stopped, and there was a decided advantage in thus getting rid of the fly-wheel.

Mr. Evans replied, this difficulty of a single cylinder was completely met in the present crane by having a small hole remaining open when the steam was shut off, which allowed steam still to pass just sufficient to keep the engine constantly moving at a slow speed, and turning only the first of the friction wheels. A double-cylinder crane would involve greater cost and complication, and a good deal of knocking was liable to occur in the gearing of a quick working crane on that plan; there was also the objection of water accumulating in the cylinders when standing, which was avoided by having the engine always moving.

Mr. H. Maudslay thought it a good idea to put the boiler at the back end to balance the jib, which made an advantageous arrangement. In a 30-ton steam crane recently erected in the wharf at Messrs. Maudslay, Son & Field's works, the engine was fixed upon the jib, consisting of a pair of small cylinders, with short stroke, working cranks at right angles; the crane lifted 30 tons and the lowering and raising were done very smoothly by the cylinders; for lowering such a weight double cylinders were of course wanted, to prevent a jerk.—*Proc. Inst. Mech. Engineers.*

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*On Road Locomotives.** By the Earl of CAITHNESS.

My present object is not to enter into any detailed history of the steam engine from its commencement, or to trace its gradual improve-

* From the London Civ. Eng. and Arch. Jour., August, 1860.

ment, but to place before you as briefly as possible some of the advantages that may accrue from it as a means of transit on our common roads.

The public mind is usually set against any thing new. When steamers were first spoken of they were looked on as a most wild and dangerous expedient. They would be constantly on fire,—would not, or could not go to sea,—and if they did, who would be found mad enough to go with them? Mr. Miller, of Dalswinton, found this to the cost of mind and person; and Mr. Bell, though more successful with his first boat on the Clyde, had his battle to fight against public opinion. Railways at first were looked on as wild and visionary, and dangerous in the extreme to Her Majesty's subjects. Thanks to George Stephenson, his perseverance had its reward, not only to himself, but in a much larger degree to us.

My object is to lay before you what in my opinion may some day work nearly as great a benefit on society as our railways. The subject is not new, but I am not aware that it has ever been brought before the British Association. It is road locomotion by steam. It seems the more important at this time to discuss the subject, as at present a bill is before parliament to enact certain tolls on locomotives; and so much fear is expressed by various parties as to the freedom from danger of these machines, that I think it a favorable opportunity to bring the subject before the meeting. Various plans have been tried, and vast sums of money expended, in endeavoring to perfect a good road locomotive. Watt designed one to carry two persons, but it was not constructed, his other employment taking up so much time as to prevent him carrying it out. The first actual steam carriage we read of was made by a Frenchman named Cugnot, who showed it to Marshal Saxe in 1763. He afterwards made one that, when first set in motion, went through a wall, and being by this means or other violent exhibition of its powers considered very dangerous, was placed in the Arsenal Museum at Paris, where it now is. An American, Oliver Evans, also invented a steam carriage in 1772, but it did not come into use. William Symington conceived the same idea for Scotland, but the roads were then so bad, that, to speak in a slang way, it was "no go;" this was in 1786. The next inventor was William Murdoch, who in 1784 made a model of a steam carriage, which is still in possession of a relative of Murdoch's. Another inventor of steam carriages was Thomas Allen, of London, who in 1789 designed one to carry goods and passengers.

The most successful, however, seems to have been a locomotive built by Richard Trevethick, of Cornwall, and Andrew Vivian, his cousin, (Trevethick was a pupil of William Murdoch.) He took out a patent for it in 1802. His carriage was like a common stage-coach. It had only one cylinder. This was the first successful engine made to work with high-pressure, moving the piston both ways against the pressure of the atmosphere only. The first road steam-carriage was, on the whole, wonderfully successful. It caused great excitement in his neighborhood. This carriage safely reached London, and was publicly exhibited on an inclosed piece of ground where Euston-station now stands.

Having thus shown that in the early days of steam, carriages were made and driven on common roads, I am about to bring the subject before this meeting, in the hope if it is now taken up, and backed by the British Association, we shall have this most useful, and now well understood power, brought to bear as a most efficient means of conveying heavy goods and passengers, as tenders to our railways, instead of making so many short branches of railways that do not pay.

Mr. Scott Russell, many years ago, made a successful steam carriage that ran between Glasgow and Paisley; and if it had not been for a most unfortunate misunderstanding between the promoters of the carriage and the road trustees, whereby a fatal accident took place, I believe it would then have made a great stride in the right direction. It performed its journey very well for some time.

One of the great reasons why we may now look for success in road locomotives is, that instead of as formerly having a heavy machine or carriage worked with a comparatively light pressure of steam, we now have a light carriage and worked at a heavy pressure. We now have the means of making very strong boilers very light, and to stand a high pressure.

A number of plans have been tried, all more or less successful. The first one that came out of late was Mr. Boydell's, with its endless railway attached to its wheels. This carriage, though I have not seen it at work, has, I understand, drawn great weights after it at a cost much less than that of horse-power; and though clumsy in appearance, yet that may be got over. The first thing in my mind is to establish the actual working of this mode of hauling.

We have now another and also a most successful steam carriage in Mr. Bray's. It is very ingenious. It has now been working for some time with perfect success; and though it was unfortunately transmogrified last year into a green dragon, and for a time gave in, yet there is no reason why it should not turn out a most useful machine. Indeed it has proved itself so a great many times within a few months, in taking large loads through London. It has drawn over thirty tons through the most crowded thoroughfares of London, and in no instance has any accident occurred during its employment. The economy in its use has been equal to a saving of one-half the cost of employing horse-power.

Mr. McConnell, to whom the world is largely indebted for very valuable improvements in the locomotive engine, has, I believe, undertaken to give his able attention to this subject, with a view to bring out a simpler engine than that now in use. This I feel can be done with ease, so as to make a much more workable and less costly machine. I think great speed should not be looked for in traction engines. What is wanted, in my opinion, is a means of taking large loads at a small cost. It is a great mistake to suppose that injury is done to the road by the use of steam carriages. The truth is that there is much less injury done than by using horses,—the broad wheels acting like rollers, and so rather improving than hurting the road.

The Marquis of Stafford has had a small steam carriage in use now for two years, and it works with great ease. It was made by Mr. Rickett, of Castle Foundry, Buckingham. Since it was made Mr.

Rickett has made two others, introducing great improvements, being direct acting instead of being driven by a pitch chain. One of these carriages has been built for myself. It weighs one ton and a half, and I have had a speed of nearly twenty miles an hour out of it. I gave a suggestion as to the mode of placing the axle in connexion with the driving gear, which I will explain. I placed the axle of the road wheel in radial segments, so that the springs rise and fall by the action of the road, the driving gear or toothed wheels are never allowed to be at a greater distance from each other at any time; the axle as it rises or falls performing a part of a revolution round a crank shaft, on which is fixed the smaller wheel which gives the action to the road wheels. Its action is perfect, as the teeth of the wheels are always in gear to the same depth; and the consequence is that the springs act most perfectly, and it goes along the road without trouble. I have now had several trips on it from Buckingham to Wolverton, a distance of ten miles, and this has been done within the hour including stoppages.

Another advantage of steam on roads over horse-power is, that instead of requiring twenty or thirty horses, forming quite a troop, to take a carriage containing some heavy weight, you place before the said carriage a steam engine. This power will cost but a small sum in comparison with horses; it will be a constant power so long as it gets coal and water. It will take up but little room, not being much larger than a common carriage. This seems a most important reason for the advancement of steam, as at this present day saving of time, money, space, and at the same time gaining increase of power, are cogent reasons for advocating any cause.—*Proc. Brit. Assoc.*, 1860.

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*Horse Railways on Common Roads.** By John Crane.

To the Editors of the Mechanics' Magazine:—

Gentlemen:—Perfectly agreeing with yourselves and Messrs. Train & Burn in the advantages to be derived from horse railways, I humbly crave a corner in your able and liberal Magazine for a brief exposition of my own views on a mere matter of debateable detail. It strikes me that there is no need whatever for the vehicles that run on rails in public streets to have flanched wheels, which would prevent their running except on such rails; but that the present wheels might be retained, provided all the axletrees were made the same length, and a form of rail adopted like that in Fig. 1. It may be called a "trough rail," and is five inches wide inside, with two flanches, and to be fixed on continuous longitudinal wooden sleepers, or embedded in stone blocks laid down at intervals of about four feet. I also recommend a stone curb to be laid along each side of the rail, such as is now generally used for curbing

Fig. 1.

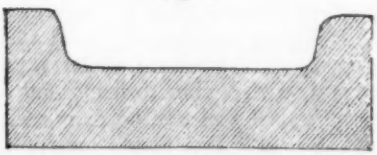


Fig. 2.

* From the Lond. Mechanics' Magazine, June, 1860.

foot-paths. But if a flanched wheel be preferred, then I think the form of the rail in Fig. 2 is better suited to meet the various requirements of the case than any I have yet seen. Each could be made either of wrought or cast iron, and of course of any dimensions to suit the particular traffic. I will not now take up any more of your space or your readers' time by enlarging on the advantage of my proposed plans, but conclude by assuring you that—whether they are novel or not—I shall not patent them, but present them to the public gratuitously.

59 Lee Crescent, Birmingham, May 31, 1860.

For the Journal of the Franklin Institute.

New Rule for Depths of Keystone for either Segmental or Elliptic Arches of Stone. By JOHN C. TRAUTWINE, C.E., Philada.

I submit the following original rule for determining the depth of keystone for either segmental or elliptic arches of stone, as coinciding more nearly than any other with which I am acquainted, with the practice of the best engineers:

For first class cut-stone work of hard material take ·36 of the square root of the radius at the crown. For second class work ·4; and for brick or rubble arches ·45 of the same square root.

The following examples will show the accordance of the rule with existing structures both elliptic and segmental, in the first case, viz: with first class work and materials.

$$\cdot 36\sqrt{\text{Radius at crown.}}$$

	Span in feet.	Rise in feet.	Rad. at Crown in feet.	Actual Key in feet.	Calcul'd Key in feet.	Engineer.
Cabin John Aqueduct, and Roadway Arch of the Washington Aqueduct,*	220	57¼	134¼	4·16	4·17	Meigs.
Grosvenor Bridge, across the Dee,	200	42	140	4·00	4·26	Harrison.
London Bridge (new), Thames,	152	29½	162	4·75	4·58	Rennie.
Gloucester Bridge, Severn,	150	35	150	4·50	4·41	Telford.
Claix Bridge, France,	150	54	82	3·10	3·26	
Dora, Turin,	148	18	160	4·80	4·55	Mosca.
Neuilly, as designed,	128	32	160	5·30	4·55	Perronet.
Neuilly, as it exists on account of the settlement of the arches,	128		250	5·30	5·69	Perronet.
Licking Aqueduct, Ches. and Ohio Canal,	90	15	76	2·83	3·14	Fisk.
Staines Bridge,	74	9·3	78—	3·00—	3·18	Rennie.
Bow Bridge, England,	66	13·75	81	2·50	3·24	Walker and Burges.
Monocacy Aqueduct,	54	9	50·0	2·50	2·55	Fisk.
Lugar Viaduct, Scotland,	50	25·00	25·0	2·00	1·80	Miller.
James River Aqueduct,	50	7	47·0	2·66	2·47	Ellet.
Reading Railroad, at Reading,	31	5	26·8	1·66	1·86	Steele.
Semi-circle,	2·0	1·00	1·0		0·53	
Pont Napoleon Viaduct, Paris, small rubble masonry in cement; multiply by ·45,	115·5	14·75	120	4·00	4·93	Couche.
Maidenhead Viaduct, brick in cement; multiply by 45	128	24·25	160·0	5·25	5·85	Brunel.

Our public works abound with cut-stone arches having keys varying from ·36 to ·4 of the square root of the radius of the crown, and with rubble arches having keys from ·4 to ·45 of the same square root; but I have not thought it necessary to introduce them.

*This is the largest stone arch of modern times, or, *perhaps*, of any former period, unless we except the ancient bridge of Trezzo, *said to have been* 251 feet span; it was designed, and its erection superintended by Capt. Montgomery C. Meigs, of the U. S. Topog. Engineers.

MECHANICS, PHYSICS, AND CHEMISTRY.

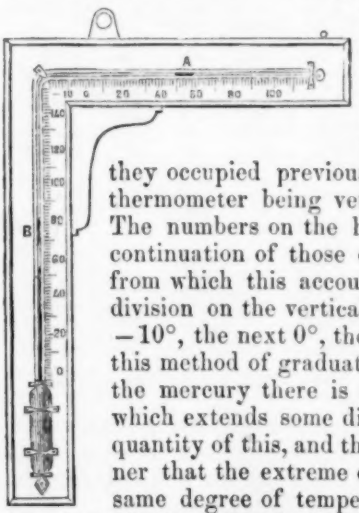
*Hicks' Maximum and Minimum Mercurial Thermometer.**

The following description of a new maximum and minimum mercurial thermometer invented by Mr. James Hicks, was written by Balfour Stewart, Esq., and communicated to the Royal Society by J. P. Gassiot, Esq.:—

About a fortnight since, Mr. James Hicks, the intelligent foreman of Mr. L. P. Casella, optician, called at Kew Observatory with an instrument of the accompanying description, for the purpose of having it compared with the ordinary maximum and minimum thermometers. This comparison proving very satisfactory, and the principle of the instrument commending itself to Dr. Robinson, Mr. Gassiot, Professor Walker, and several other scientific men who examined it, Mr. Gassiot requested me to write a short description of it, which he thought might be of interest to the Royal Society. For many particulars of this description I am indebted to Mr. Casella, and Mr. Hicks, who furnished me with details regarding the construction of the instrument.

Its chief advantage consists in its furnishing us with a mercurial minimum thermometer, no serviceable instrument of this description having hitherto been made. At the same time it is also capable of being used as a mercurial maximum thermometer.

The principle of the instrument is briefly as follows:—It has a cylindrical bulb nearly three and a half inches long and half an inch in diameter, filled with mercury. This gives a bore nearly $\frac{1}{20}$th of an inch wide, and a scale on which 1° Fahrenheit corresponds to about $\frac{1}{20}$th of an inch, when the graduation has reached 150° F. or so; both the tube and the scale are made to assume a position at right angles to that which they occupied previously, so that the first portion of the thermometer being vertical, the second will be horizontal. The numbers on the horizontal scale are not, however, in continuation of those on the vertical, for in the instrument from which this account is taken, while 150° is the highest division on the vertical scale, the first on the horizontal is −10°, the next 0°, the third 10°, and so on. The reason of this method of graduation will immediately appear. Above the mercury there is a small quantity of spirits of wine, which extends some distance into the horizontal tube. The quantity of this, and the graduation, correspond in such manner that the extreme end of the spirit column denotes the same degree of temperature as the mercury. The remainder of the horizontal tube is filled with air. There are two movable indices in the spirit column, one in the vertical tube, the other in the horizontal, each about half an inch long. The former, B, consists of



* From the Mechanics' Magazine, June, 1860.

a fine steel magnet inclosed in glass. This forms the body of the index. At either extremity there is a head of black glass, similar to that which occurs in the index of an ordinary minimum themometer. A fine hair is tied round the neck of this index, between the body and the upper head; and it is made to hang down by the side so that by its elastic pressure against the tube the index may be kept in its place notwithstanding its verticality. The index in the horizontal tube A is in all respects similar to that of an ordinary maximum thermometer.

Let us now suppose the instrument fixed in its position, the first part of the stem being vertical. In order to adjust it we must first bring the vertical index into contact with the upper extremity of the mercurial column. To do this, let us take two small but strong horse-shoe magnets, and lay the one above the other, so that the poles of the one shall overlap to a small extent the corresponding poles of the other. Bring the magnets up to the index in such a manner that, while the poles of the one bear against the side of the glass tube, the overlapping poles shall lie over the tube so as to be in front of the index; the index will now follow the motion of the magnets, and it may thus be brought down to the surface of the mercury. In order to bring the horizontal index to the extremity of the spirit column, all that is necessary is to incline the horizontal tube a little downwards by pressing on the end. The indices being now set and the instrument in adjustment, let us suppose the temperature to rise—the mercurial column will push the vertical index up, but this index will remain in its place when the mercury again falls, and will, therefore, denote the maximum temperature reached. On the other hand, let us suppose the temperature to fall—the mercury in falling is followed by the spirit column propelled by the air behind it. The spirit column again will, on its edge coming in contact with the end of the horizontal index, draw the index with it into a position, where it will remain when the mercury again rises. This index will, therefore, register the extreme minimum point which the spirit column has reached; but by the principle of graduation this will correspond with the minimum point reached by the mercurial column.

Let us now suppose that a small portion of the spirit column has become separated, and lodged itself in the extremity of the tube. The principle of graduation will immediately enable us to discover this by a want of correspondence being produced in the reading of the mercurial and of the spirit columns. If, for instance, before the separation the mercury read 50°, and the horizontal extremity of the spirit column also 50°, it is clear that, after the abstraction of spirits has taken place, the horizontal column will read lower. We have thus a check upon this possible source of error, which we have not in the ordinary minimum thermometer. Indeed, it is to all intents a mercurial minimum thermometer that we are now describing, the spirits serving merely as a vehicle for the indices. It will be remarked that were both columns capable of acting in a horizontal position, there would be no necessity for the bend, and the instrument would be more portable; but in this position it is found there is danger of the spirits becoming

mixed with the mercury, and thus interfering with the action of the instrument. Should this ever be brought about by traveling, or any cause, a smart jerk or two of the instrument will join the separated columns and put all right.

The instrument is thus constructed:—The vertical tube, including the bulb, is first made and filled with mercury to the proper height, and the magnetic index is introduced; then the horizontal tube is joined, and the spirits of wine and the horizontal index are introduced. The bulb is then placed in a freezing mixture, in order that the mercury may retreat as far as possible, followed by the spirits of wine. The tube is then sealed, care being taken that the bore shall end in a small rounded chamber; for, if pointed, some of the spirits would be apt to lodge there, whence it would be difficult to remove it. The object of cooling the bulb before sealing off is, that we may have as much air in the tube as possible, for its pressure, as already mentioned, enables the spirits to follow the mercury when the latter falls.

To graduate the instrument, set it with the mercurial stem horizontal in melting ice, then point off the extremity of the mercurial, and also of the spirit column as corresponding to 32° F. Perform a similar operation in water 42°, 52°, 62°, &c., and also in freezing mixtures down to zero, or lower if necessary.

In conclusion, if used as a wet-bulb thermometer, this instrument will give us the maximum and minimum temperatures of evaporation obtained under precisely the same circumstances.

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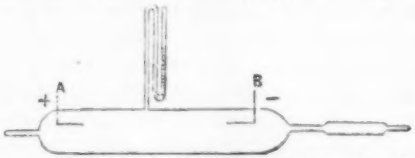
*On Indications of Vacua.**

An interesting paper "On Vacua as Indicated by the Mercurial Siphon-gauge and the Electrical Discharge" was recently read at the Royal Society, by J. P. Gassiot, Esq., F. R. S. The following is an abstract of it:

"That the varied condition of the stratified electrical discharge is due to the relative but always imperfect condition of the vacuum through which it is passed, is exemplified by the changes which take place in the form of the striæ while the potash is heated in a carbonic acid vacuum-tube. In order, if possible, to measure the pressure of the vapor, I had a carefully prepared siphon mercurial gauge sealed into a tube 15 inches long, at an equal distance between the two wires A B. This tube was charged with carbonic acid in the manner described by me in a former communication. When exhausted by the air-pump and sealed, it showed a pressure indicated by about 0·5 inch difference in the level of the mercury; the potash was then heated; the mercury gradually fell until it became perfectly level. Dr. Andrews (*Philosophical Magazine*, February, 1852,) has shown that with a concentrated solution of caustic potassa, he obtained



* From the London Mechanics' Magazine, June, 1860.

with carbonic acid a vacuum with the air pump so perfect as to exercise no appreciable tension, as no difference in the level of the mercury in the siphon-gauge could be detected. On trying the discharge in the vacuum-tube after the potash had cooled, I found it gave the cloud-like stratifications, with a slight reddish tinge; consequently not only was the vacuum not perfect, as denoted by the form of stratifications, but in this tube the color denotes that even a trace of the air remains, probably that portion in the narrow part of the siphon-gauge, which, from its position, was not displaced by the carbonic acid."

"The potash was subsequently heated until the discharge was reduced to a wave line, with very narrow striæ; in this state moisture is seen adhering to the sides of the tube; but even in this state the difference in the level of the mercury in the gauge did not ever vary more than ·05 inch. As the potash cooled, the discharge altered through all the well-known phases of the striæ, the mercury again becoming quite level. At first almost the slightest heat applied to the potash alters the form of the stratifications; as the heating is repeated, longer application is necessary; but it shows how sensibly the electrical discharge denotes the perfection of a vacuum, which cannot be detected by the ordinary method of mercurial siphon-gauge.

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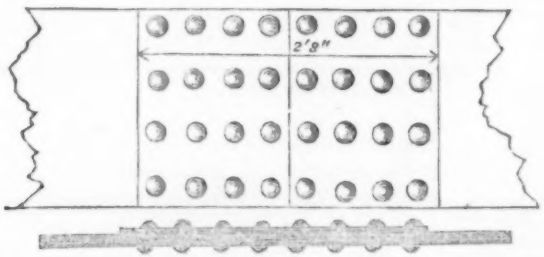
*Chain Riveting.** By W. Fairbairn, Esq., LL.D., F.R.S., &c., &c.

In the formation of the bottom of a tubular girder, whether composed of cells, as in the Britannia and Conway bridges, or of double plates, as in smaller examples, it is of importance to have as few joints as possible. Hence the plates should be rolled as long as their weight and thickness will allow, and the joints be carefully united by covering plates, *chain riveted*, as shown in the following sketch, with three or more rows of rivets, according to the width of the plates. Eight



rivets are required in each of the lines, four on each side of the joint, to give sufficient strength, and the area of the rivets collectively should be equal to the area of the jointed plates, taken transversely through one line of the rivets, the area of the parts punched out in that line being deducted. These proportions give the required security to the joint, and afford nearly the same strength to a tensile strain as the solid plate; that is, if the covering plates be as much thicker as will give the same area of section through the rivet holes as the imperfo-

* From the Lond. Mechanics' Magazine, June, 1860.

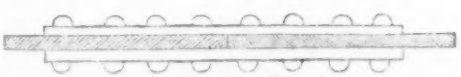
rated double plate. These precautions being taken in covering the joints of the plates and in securing the angle irons which unite the sides with the bottom, it will meet in practice all the requirements of a uniform power of resistance to strain from one end of the girder to the other.

In a long experimental inquiry which I undertook some years since, it was shown that there was a loss in the riveted joint, as compared with the solid plate, of 30 to 50 per cent.; that is, taking the strength of the solid plate at 100, that of the double riveted joint would be 70, and that of the single riveted joint 50.

This great deficiency in the strength of joints subjected to a transverse strain, caused considerable difficulty in designing the Britannia and Conway bridges; double, treble, and quadruple riveting was thought of; but one after another was abandoned, on account of the rivet holes weakening the plates; and I should almost have despaired of attaining the object in view, but for the system of longitudinal or chain riveting having occurred to me, after repeated trials of other modes and forms. Experiment, however, established the perfect security of this method, as the following tables clearly demonstrate. Two distinct methods were tried, one with a single thickness of plates, the joint having a covering strip on each side; the other with two thicknesses of plate, there being a joint in one of them covered by a plate, and kept in position by a line of rivets as already described. The jointed plates having been prepared, the experiments were effected by a powerful lever, tearing the joints and plates asunder in the direction of the line of rivets.

Chain Riveting. Single Plates, with double Covers over the Joint.

No. of Experiment.	Weight in lbs.	Elongation in inches.	Remarks.
1	5,600		Weight of the lever.
2	26,656		
3	28,448		
4	30,240	·021	
5	32,032	·034	
6	33,824	·034	
7	35,626	·044	
8	37,418	·052	
9	39,210	·056	
10	41,002		Torn asunder through a rivet hole after sustaining the load a few seconds.



		Sq. in.
Area of section through solid plate, . . .	3·5 × ·25	= ·875
Area of the covering plates, . . .	3·5 × ·26	= ·910
Area of section through rivet hole, . . .	3·0 × 25	= ·750

Diameter of the rivets, each ½ inch, four on each side of the joint.

If we take the area of the plate at the point of fracture = ·750 inch, it will be found that it required a power of 24·41 or nearly 24½ tons per square inch to tear it asunder.

From the following experiment, it appears that the fracture took place through the solid plate on one side, and by shearing off the rivets on the other. Hence the area of section of fracture $= \cdot 875 \times \cdot 785 = 1 \cdot 66$ inches, and proceeding as before, we have 18·73 tons per square inch as the breaking weight.

Chain Riveting. Double Plates, and a single Cover over the Joints.

No. of Experiment.	Weight in lbs.	Elongation in inches.	Remarks.
1	5,600		Weight of the lever.
2	26,656	·016	
3	37,408	·025	
4	46,368	·028	
5	55,328	·075	
6	62,496	·100	
7	69,664		Broke by shearing off the rivets close to the plate.

		Sq. in.
Area of section through plates,	$2 \times \cdot 875$	$= 1 \cdot 750$
Area of section through rivet holes,		$= 1 \cdot 5$
Area of covering plate through rivet holes,		$= 0\ 91$

Rivets as before, ⅞-inch diameter.

Finding the resisting powers of the rivets unequal to the strength of the double plates, they were afterwards increased from half an inch to five-eighths of an inch in diameter, or until the area of the rivets approached nearly to the area of the plates, which gave the required strength. In joints of this description it will be found that the resisting powers of the rivets is nearly equal to that of the plates, *i.e.*, the resisting power of the rivet is to that of the plates as their sectional areas respectively. This is an agreement with the following laws, which have been deduced from experiment:—1st, that the ultimate resistance to shearing, in any bolt or rivet, is proportional to the sectional area of the bar torn asunder; and, 2d, that the ultimate resistance of any bar to a shearing strain is nearly the same as the ultimate resistance of the same bar to a direct longitudinal strain.

For the Journal of the Franklin Institute.

Particulars of the Steamer Zouave.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, Sandford's Independent Line, New York to Philadelphia.

Hull.—Length on deck, 220 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. 3 ins. Frames, molded, 14 ins.,—sided, 6 ins.,—24 ins. apart from centres, and strapped with diagonal and double laid braces, $4 \times \frac{1}{2}$ in. One independent steam fire and bilge pump. One bulkhead. Promenade deck with saloon, cabin, and state-rooms. Draft of water forward and aft, 6 ft. 6 ins. Area of immersed section at load draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner. Tonnage, 800 tons.

Engines.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke, 11 ft. Cut-off, one-half.

Boiler—One—Return flued. Length of boiler, 27 ft. Breadth of do., (front) 13 ft. Height of do. exclusive of steam chimney, 11 ft. 3 ins. Number of furnaces, two. Breadth of do., 5 ft. 9½ ins. Length of grate bars, 7 ft. 6 ins. Number of flues, below, ten—2 of 22½, and 4 each of 15 and 17 ins.—above, twenty—10 each of 8½ and 9½ ins. Length of flues, above, 20 ft. 8 ins., below, 14 ft. Diameter of smoke pipe, 52 ins.

Paddle Wheels—Diameter over-boards, 31 ft. Length of blades, 7 ft. Depth of do., 24 ins. Number of do., 27.

Date of trial, November, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the U. S. Steamer Seminole.

Hull built by United States Government. Machinery by Morgan Iron Works, New York.

Hull.—Length at load line, 200 ft. Breadth of beam (molded), 28 ft. Depth of hold to spar deck, 14 ft. Length of engine room, coal bunkers, &c., 48 ft. Two bulkheads. One independent steam fire and bilge pump. Draft of water forward and aft, 10 ft. Tonnage, 755 tons. Area of immersed section at load draft of 10 ft., 264 sq. ft. Capacity of coal bunkers, 220 tons. Masts, three—Rig, Bark. Speed in knots, 9.

Engines.—Two, horizontal steeple. Diameter of cylinders, two of 50 ins. Length of stroke, 2 ft. 6 ins. Maximum pressure of steam, 50 lbs. Cut-off, one-half. Maximum revolutions at above pressure, 80.

Boilers—Two, and one donkey. Vertical tubular. Length of boilers, 22 ft. Breadth of do., 10 ft. 6 ins. Height of do. exclusive of steam chimney, 10 ft. 3 ins. Number of furnaces. 12. Breadth of do., 3 ft. Length of grate bars, 5 ft. 6 ins. Number of tubes, 3685. Internal diameter do., 2 ins. Length do., 2 ft. 7½ ins. Diameter of smoke pipe, 6 ft. Height of do., 42 ft.

Propeller.—Diameter of screw, 9 ft. 6 ins. Pitch of do., 18 ft. Number of blades, two.

Date of trial, May, 1860. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamer New Brunswick.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, International Steam-ship Company. Intended service, Portland to St. Johns, N. B.

Hull.—Length on deck, 224 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. Frames—molded, 14 ins.—sided, 6 ins.—apart at centres, 24 ins. and strapped with diagonal and double laid braces, 4 × ½ in. Independent steam fire and bilge pumps. Promenade deck with saloon, cabin, and state-rooms. One bulkhead. Draft of water, forward and aft, 6 ft. 6 ins. Tonnage, 815 tons. Area of immersed section at draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner.

Engine.—Vertical beam. Diameter of cylinder, 48 ins. Length of stroke, 11 ft. Cut-off, variable.

Boiler—One—Return flued. Length of boiler, 26 ft. 2 ins. Breadth, front, 13 ft. Height, exclusive of steam chimney, 11 ft. 6½ ins. Number of furnaces, two. Breadth do., 5 ft. 9½ ins. Length of grate bars, 7 ft. 6 ins. Number of flues, above, 6, below, 10. Internal diameter of flues, above, 1 ft. 5 ins., below, 2 of 22½ ins., and four each of

15 and 17 ins. Length of flues, above, 18 feet 6½ ins., below, 13 feet 2 ins. Diameter of smoke pipe, 4 feet 4 ins.

PADDLE WHEELS.—Diameter, over boards, 31 feet. Length of blades, 7 feet. Depth do., 22 ins. Number do., 27.

Date of trial, October, 1860. C. H. H.

Translated for the Journal of the Franklin Institute.

On the Elastic Force of Vapors. By M. V. REGNAULT.

"I presented to the Academy, in August, 1854, the principal results of the experiments which I had made to determine the laws which exist between the elastic forces of vapors and the temperatures to which they are subjected. This work is a portion of a long series of investigations, the first part of which was published in 1845,* the principal object of which is to collect the physical elements necessary to calculate the theoretical work which can be obtained from a substance, either when it is transformed into an elastic fluid by means of a known quantity of heat, or when the elastic fluid, losing a certain quantity of heat, develops a known moving power, either in resuming the liquid state as in the condensing steam engine, or simply in increasing in volume, as occurs in high pressure steam engines and in hot-air engines.

"The law which connects the elastic forces of gases and vapors with their temperature necessarily plays an important part in this general question. Moreover, it appears that it ought to be one of the simplest of the theory of heat, because it depends only upon two elements which are clearly defined and susceptible of precise determination, the temperatures and the pressures which the elastic forces balance.

"This announcement will explain the interest which I attached to an investigation of this sort, and the perseverance with which I collected its elements. In fact, my work extends from gases which have been liquefied by compression, to substances, such as mercury and sulphur, whose boiling-points are not so high but that they may be kept in ebullition, under high pressures, in apparatus which can now be constructed.

"The Memoir which includes the whole of these observations has been printed for several years; it forms a part of vol. xxvi, of the Memoirs of the Academy. The publication has been delayed by circumstances beyond my control, and particularly by the necessity of myself tracing upon the plate, as I did for steam (*Memoirs of the Academy*, vol. xxi,) the points determined by each separate experiment, and the curves which exhibit their connexion.

"This Memoir, as I announced in 1854 (*Comptes Rendus*, vol. xxxix, pp. 301, 345, 397), is divided into five parts:

"1st. The first includes my examinations into the elastic forces of saturated vapors through a great range of temperatures.

"2d. The second treats of the elastic forces of vapors emitted by saline solutions, and of their boiling-point under different pressures.

* See Journ. Frank. Inst., present series, vols. xv, xvi, and xvii.

"3d. In the third, I study the elastic forces of these same vapors in the air and in other gases.

"4th. The fourth treats of the elastic forces of vapors from two volatile liquids, either dissolved in one another, or simply superposed when they exercise no mutual dissolving action.

"5th. Finally, in the fifth, I endeavor to determine whether the solid or liquid state of the same body exercises any influence for the same temperature over the elastic force of the vapor which it emits.

"I shall not here again allude to the last four parts of the Memoir; the general conclusions which I thought could be drawn from my experiments appear to be sufficiently expressed in the *Comptes Rendus* of 1854. I ask of the Academy only the permission to give it some developments of the first part, that which treats of the elastic forces of saturated vapors *in vacuo*, of which I could cite but a few examples in my communication in 1854.

"The various apparatus which I used in these researches are described in the Memoir; I shall not dwell upon them; remarking only that they are referable to two different methods.

"The first, which I call the *statical method*, consists in determining the pressure which equilibriates the elastic force of the vapor, *at rest*, which a liquid in excess emits at various temperatures. In the second method, which I call the *dynamical method*, the vapor is always in motion, and we determine the temperature of the vapor which the liquid *continually* emits when boiling under different pressures.

"These two methods give results which are identical:

"1st. When the liquid is perfectly homogeneous. It is not so when it is impure; the presence of the smallest quantity of a volatile foreign body shows itself immediately by the non-superposition of the two graphical curves belonging to the two methods.

"2d. When the liquid has not a great molecular attraction. In the opposite case the liquid boils intermittently with violent starts, and the determinations by the dynamical method become very uncertain.

"The two methods could be successfully applied to the greater part of the volatile substances which were submitted to my experiments, and they have enabled me to determine their elastic forces from the lowest temperatures up to those which correspond to pressures of from 12 to 15 atmospheres. The greatest part of the gases liquified by pressure give liquids which possess great molecular attraction and resist ebullition notwithstanding their extreme mobility. Their elastic forces can only be certainly determined by the statical method. When we wish to apply the dynamic method, the thermometer cannot be placed in the vapor of the boiling liquid unless the boiling-point is above the temperature of the surrounding air; for if it be inferior, the vapor may become overheated, and the indications of the thermometer will be wrong. If the thermometer is placed in the boiling liquid, it does not show a constant temperature during ebullition, although the pressure remains the same. The indications of the thermometer change much according to the manner in which the heat is applied. The boiling is not continuous; it takes place with violent

shocks, which are attended by a sharp noise like that of the water-hammer when it is suddenly inverted. These effects vary much with the pressure under which the boiling takes place. Certain liquids present them even under pressures below that of the atmosphere; in others they appear only under high pressures.

"The limits to which I am obliged to confine myself in this *résumé*, do not allow me to state the individual observations which I have made on each substance, nor even to explain the method of graphical construction, nor the formulæ of interpolation by which I endeavored to express the results of my experiments in the best way. I will remark only, that of all the modes of interpolation which were successively tried, the formula by exponential series, proposed by De Prony and applied by M. Biot, to the vapor of water under the form

$$\text{Log. } F = a + b\alpha^t + c\beta^t$$

is the one which applied most exactly to all the substances studied. This formula has, besides the advantage of containing five constants, for the determination of which, five points of the graphic curve, having equidistant abscissæ, may be selected, so that the curve represented by the formulæ can vary but very little from the curve traced through the intermediate points. Moreover, I show in my Memoir that for a great number of the substances studied, we may, by a convenient adjustment of the fixed points which serve to calculate the constants, without sensibly departing from the data of direct observation, calculate a formula with two exponentials

$$\text{Log. } F = a + b\alpha^t + c\beta^t,$$

in which the term $c\beta^t$ introduces only quantities less than the errors of observation, so that it may be reduced to the more simple one,

$$\text{Log. } F = a + b\alpha^t.$$

"This consideration and the great resemblance which the curves traced for the different substances have to each other, when the ordinate is taken equal to $\frac{F}{760}$, leads me to think that the law of the elastic forces and temperatures would present itself under a very simple form, if for the variable independent we should assume not the temperature as we define it in an entirely arbitrary manner, but another element which should be immediately connected with the constitution of each body, and whose origin should be fixed for each one of them.

"I have in the following tables presented the elastic forces of the different vapors, calculated for temperatures varying by 5°, according to the formulæ which I calculated from my experiments. The temperatures are those of the mercurial thermometer which I used. In my Memoir, I also give the corresponding temperatures taken by the air thermometer. The reduction of the temperatures from the mercurial to the air thermometer was determined by especial experiments.

TABLE No. 1.

LIQUIDS OF MEAN VOLATILITY. BOILING-POINT BETWEEN 14° AND 150° CENT.

	ALCOHOL.	ETHER.	SULPHURET OF CARBON.	CHLOROFORM	BENZINE.	CHLORIDE OF CARBON. C_2 Cl_6.
T.	F.	F.	F.	F.	F.	F.
°	mm.	mm.	mm.	mm.	mm.	mm.
— 25					2,37	
— 20	3.34	67,49	43,48		4,94	
— 15	4,69	87,89	60,91		8,62	
— 10	6,58	113,35	81,01		13,36	
— 5	9,21	144,82	104,40		19,30	
0	12,83	183,34	131,98		26,62	30,55
+ 5	17,73	230,11	164,53		35,60	40,09
10	24,30	286,40	203,00		46,59	52,08
15	33,02	353,62	248,40		60,02	67,09
20	44,48	433,26	301,78	160,47	76,34	85,49
25	59,35	526,93	364 24	199,40	96,09	107,94
30	78,49	636,33	436,97	245,91	119,89	135,12
35	102,87	763,27	521,36	301,13	148,37	167,73
40	133,64	909,59	616,99	366,20	182,27	206,51
45	172,14	1077,22	729,72	442,37	222,37	252,31
50	219,88	1271,12	856,71	530,96	269,51	305,39
55	278,61	1484,59	1000,87	633,36	324,61	367,68
60	350,26	1728,52	1163,73	751,01	388,62	439,66
65	436,99	2002,13	1346,86	885,41	462,57	522,26
70	541,21	2307,81	1551,84	1038,09	547,51	616,48
75	665,52	2647,75	1780,28	1210,62	644,59	723,29
80	812,76	3024,41	2033,77	1404,57	756,63	843,70
85	985,97	3440,30	2313,90	1621,52	879,55	978,71
90	1188,43	3898,05	2622,23	1863,12	1019,96	1129,04
95	1423,52	4400,55	2960,30	2130,90	1177,10	1296,47
100	1694,92	4950,81	3329,54	2426,52	1352,27	1481,19
105	2006,34	5552,18	3731,37	2751,23	1546,59	1684,45
110	2361,63	6208,37	4167,18	3106,83	1761,29	1907,21
115	2764,74	6923,55	4638,14	3494,69	1997,48	2150,47
120	3219,68	7702,20	5145,43	3916,17	2256,26	2415,23
125	3730,41		5690,08	4372,73	2538,66	2702,54
130	4301,04		6273,03	4865,65	2845,66	3013,49
135	4935,40		6895,06	5396,23	3178,18	3349,28
140	5637,00		7556,88	5965,76	3537,05	3711,23
145	6410,62			6575,41	3923,00	4100,81
150	7258,73			7226,49	4336,70	4519,73
155	8185,02			7920,19	4778,69	4969,97
160				8657,72	5249,43	5453,88
165				9440,40	5749,26	5974,28
170					6278,40	6534,58
175					6837,04	7138,90
180					7425,66	7792,33
185					8042,41	8501,02
190						9272,67
195						10116,74

TABLE No. 1 (Continued).

LIQUIDS OF MEAN VOLATILITY. BOILING-POINT BETWEEN 14° AND 150° CENT.

	CHLORHYDRIC ETHER.	BROMHYDRIC ETHER.	IODOHYDRIC ETHER.	METHYLIC ALCOHOL.	ACETONE.
T.	F.	F.	F.	F.	F.
°	mm.	mm.	mm.	mm.	mm.
— 30	110,24				
— 25	145,01				
— 20	187,55			6,27	
— 15	239,60			9,29	
— 10	302,09			13,47	
— 5	376,72			19,17	
0	465,18		41,95	26,82	
+ 5	569,32		54,14	36,89	
10	691,11		69,20	50,13	
15	832,56		87,64	67,11	
20	996,23	380,30	110,02	88,67	197,89
25	1184,17	463,30	136,95	115,99	226,27
30	1398,99	559,81	169,07	149,99	281,00
35	1643,24	671,31	207,09	192,01	345,15
40	1619,58	799,35	251,73	243,51	420,15
45	2230,71	945,56	303,77	306,13	507,52
50	2579,40	1111,65	364,00	381,68	602,86
55	2668,43	1299,41	433,21	472,20	725,95
60	3400,54	1510,69	512,25	579,93	860,48
65	3878,52	1747,43		707,33	1014 32
70	4405,03	2011,57		857,10	1189,38
75	4982,72	2305,24		1032,14	1387,62
80	5614,11	2630,45		1238,47	1611,05
85	6301,61	2989,38		1470,92	1861,81
90	7047,51	3384,22		1741,67	2141,66
95	7853,92	3817,11		2051,71	2452,81
100	8722,76	4290,33		2405,15	2797,27
105		4806,11		2806,27	3177,00
110		5366,67		3259,60	3593,96
115		5974,26		3769,80	4050,02
120		6631,08		4341,77	4546,86
125		7339,33		4980,55	5086,25
130		8101,15		5691,30	5669,72
135		8918,64		6479,32	6298,68
140		9793,86		7337,10	6974,43
145				8308,87	
150				9361,35	

TABLE No. 2.

LIQUIDS BOILING ABOVE 150° CENT.

ESSENCE OF TURPENTINE.		ESSENCE OF LEMON.		METHYLOXALIC ETHER.	
T.	F.	T.	F.	T.	F.
°	mm.	°	mm.	°	mm.
0	2,07	98,99	69,80	109,41	117,26
10	2,94	115,40	129,39	109,53	117,46
20	4,45	115,10	129,09	125,98	222,67
30	6,87	124,85	178,31	126,06	222,87
40	10,80	125,03	179,01	136,45	320,11
50	16,98	137,00	263,42	145,14	423,37
60	26,46	147,35	357,04	155,70	591,36
70	40,64	155,52	449,23	164,30	761,35
80	61,30	165,08	576,50	188,92	1589,81
90	90,61	174,25	748,67	192,37	1589,81
100	131,11	174,16	749,69	217,16	2958,68
110	185,62	201,60	1439,68	228,95	3875,95
120	257,21	223,30	2328,04	237,16	4849,72
130	348,98	236,65	3213,49	164,48	763,48
140	464,02	239,70	4374,42	242,86	4867,83
150	605,20			253,53	6203,14
155	686,37				
160	775,09				
165	871,27				
170	975,42				
175	1090,11				
180	1207,92				
185	1336,45				
190	1473,24				
195	1618,26				
200	1771,47				

The experiments on the essence of turpentine were carried to much heavier pressures, but I judged it useless to transcribe them here, because they had reference only to an essence completely modified in its molecular constitution. I have in my Memoir described the series of researches by which I studied the isomeric modifications which the essence successively undergoes by its boiling under various pressures.

When these experiments were ended, the essence of lemon showed the same boiling-point at atmospheric pressure as before, but it had completely lost its power of rotating polarized light.

The boiling of methyloxalic ether is pretty steady under pressures but little above that of the atmosphere, but under heavy pressures it becomes very irregular, and produces violent starts.

TABLE No. 3.

	MERCURY.
T.	F.
°	mm.
0,0	0,0200
10	0,0268
20	0,0372
30	0,0530
40	0,0767
50	0,1120
60	0,1643
70	0,2410
80	0,3528
90	0,5142
100	0,7455
110	1,0734
120	1,5341
130	2,1752
140	3,0592
150	4,2664
160	5,9002
170	8,0912
180	11,00
190	14,84
200	19,90
210	26,35
220	34,70
230	45,35
240	58,82
250	75,75
260	96,73
270	123,01
280	155,17
290	194,46
300	242,15
310	299,69
320	368,73
330	450,91
340	548,35
350	663,18
360	797,74
370	954,65
380	1136,65
390	1346,71
400	1587,96
410	1863,73
420	2177,53
430	2533,01
440	2933,99
450	3384,35
460	3888,14
470	4449,45
480	5072,43
490	5761,32
500	6520,25
510	7353.44
520	8264,96

Note to Table 3.

"The temperatures here recorded are those of the air-thermometer. The boiling of the mercury is pretty steady under pressures below that of the atmosphere. At the atmospheric pressure the starts begin; they become more and more violent as the pressures augment, and under the pressure of 10 atmospheres the shocks are so strong as to produce a noise as loud as that of a forge-hammer striking upon the anvil. The apparatus appeared in danger of flying in pieces.

TABLE No. 4.

VERY VOLATILE LIQUIDS, LIQUEFIED GASES.

	SULPHUROUS ACID.	AMMONIA.	SULPHYDRIC ACID.
T.	F.	F.	F.
°	mm.	mm.	mm.
—78,2		157,95	441,42
—40		528,61	
—35		684,19	
—30		876,58	2808,57
—25	373,79	1112,12	3508,02
—20	479,46	1397,74	4273,01
—15	607,90	1740,91	5090,18
—10	762,49	2149,52	5915,00
— 5	946,90	2632,25	6822,74
0	1165,06	3162,87	7709,27
+ 5	1421,14	3854,47	
10	1719,55	4612,19	
15	2064,90	5479,86	
20	2462,05	6467,00	
25	2915,97	7581,16	
30	3431,80	8832,20	
35	4014,78	10144,00	
40	4670,23	11776,42	
45	5403,52		
50	6220,01		
55	7125,02		
60	8123,80		
65	9221,40		

"The condensation of the gases was effected in the same apparatus which was to serve for the determination of the elastic forces, and which was so arranged that it could be completely purged afterwards of every trace of air or other gas which might be in it. The liquefaction of sulphurous acid was easily effected under the ordinary pressure of the atmosphere when the apparatus was plunged into a freezing mixture. For ammonia and sulphuretted hydrogen, the apparatus was plunged into a mixture of ice and crystallized chloride of calcium, and the gas was then compressed by a hand-pump. Only, care must be taken to replace the ordinary grease for the pump by fixed non-saponifiable oils. A pressure of 2 or 3 atmospheres is sufficient to liquefy as much ammonia as is desired; but for sulphuretted hydrogen the pressure must be carried to 7 or 8 atmospheres.

"As I have had occasion to liquefy these gases on a large scale for researches of which I will soon present the results to the Academy, and especially for the determination of the latent heat of volatilization under different pressures of very volatile liquids, and for the examination of the quantities of heat which their vapors absorb during their expansion, I will here briefly indicate the process which I employed.

"I prepare carbonic acid gas by supplying in a continuous and regular stream, properly-diluted chlorhydric acid to fragments of marble enclosed in a very large glass vessel. The solution deprived of the acid and charged with chloride of calcium flows out as fast as it forms; the carbonic acid gas passes over to a gas receiver of a cubic capacity of 1 cubic metre. A condensing-pump with several barrels, moved by my steam engine, draws the gas from the receiver, and having caused it to pass over drying materials, it forces it into a first recipient of 3 or 4 litres capacity which serves only as a regulator; thence, the gas passes freely into the apparatus in which it is to be condensed, which is buried in a freezing mixture of ice and crystallized chloride of calcium. The gas which does not condense, passes into a second closed recipient of 5 litres capacity. Into this last vessel, the air and other more condensable gases pass, and from it they may from time to time be discharged by opening a stop-cock.

"The same arrangement will serve to liquefy large quantities of protoxide of nitrogen, or sulphuretted hydrogen. But for these gases which are easily rendered impure by contact with the grease and pistons of the pump, I employ a peculiar forcing-pump, in which the gas is in contact only with mercury. This pump is composed of two equal cast iron cylinders, united in the form of a U. The first cylinder is turned, and contains a solid piston which, in its movement, acts only on a quantity of mercury which fills exactly one of the pump cylinders. The suction and compressing (foot and head) valves are attached to the second cylinder. It will be seen that by this arrangement the gas never comes into contact with the piston or the greasy sides.

"Liquid ammonia particularly occupied my attention, owing to its great capacity for heat, its great latent heat of evaporation, and the ease with which it is prepared and collected after it has assumed the

gaseous state. I determined to use it principally for obtaining very stationary low temperatures by boiling it under different pressures. I prepare the ammonia as a gas by passing continuously a thread of a concentrated solution of ammonia into a copper tube enclosed in a small boiler containing water which is kept boiling by a gas-light. The ammonia flows in a spiral along the walls, and the liquid, nearly deprived of ammonia, escapes by a tube below, which enters to a depth of several decimetres into the liquid which has previously flowed out.

"The gaseous ammonia, sucked by the pump, traverses several copper recipients filled with soda-lime. The pump itself regulates the production of the gas, and delivers it into the receiver, which is buried in a freezing mixture of ice and hydrated chloride of calcium. By means of this arrangement several litres (quarts) of liquid ammonia may be obtained in a few hours.

"To submit an apparatus to a stationary low temperature, it is hermetically adjusted in the condenser, and the liquid ammonia is condensed in this receiver buried in a freezing mixture. When it is sufficiently filled with the liquid, the freezing mixture is removed and the receiver placed in communication with one of my large air-reservoirs, in which the pressure is kept rigorously stationary, either above or below that of the atmosphere.

"The ammonia thus distils under pressures as light as are desired, which are easily kept perfectly constant, provided the ammoniacal gas is prevented from reaching the air-reservoir. For this purpose, in front of this reservoir is placed a cylindrical vessel containing pieces of ice, which, as they liquefy, almost entirely re-dissolve the ammonia; and after this, another cylinder filled with large pieces of pumice stone soaked with acid.

"I thus hoped to obtain, by means of this apparatus, low temperatures which should be perfectly stationary, but I was not successful for reasons which I have explained before (p. 242). A certain amount of steadiness can only be obtained by passing a continual current of small bubbles of air through the liquid ammonia, which thus continually stirs up the liquid and destroys its viscosity. An air thermometer should be placed in contact with the apparatus experimented on, and plunged entirely in the liquid ammonia; by means of a regulating screw, the current or air-bubbles is controlled so as to keep the thermometer stationary.—*Comptes Rendus de l'Academie des Sciences de Paris*, 11 *Juin*, 1860.

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*On Microscopic Vision and a new Form of Microscope.** By Sir. D. Brewster.

In studying the influence of aperture on the images of bodies as formed in the camera, by lenses or mirrors, it occurred to me that in microscopic vision it might exercise a still more injurious influence. Opticians have recently exerted their skill in producing achromatic object-glasses for the microscope with large angles of aperture. In 1848 the late distinguished optician, Mr. Andrew Ross, asserted "that

* From the Lond. Athenæum, July, 1860.

135° was the largest angular pencil that could be passed through a microscopic object-glass," and yet in 1855 he had increased it to 170°, while some observers speak of angular apertures of 175°. In considering the influence of aperture, we shall suppose that an achromatic object-glass with an angle of aperture of 170° is optically perfect, representing every object without color and without spherical aberration; when the microscopic object is a cube, we shall see five of its faces, and when it is a sphere or a cylinder, we shall see nine-tenths or more of its circumference. How, then, does it happen that large apertures exhibit objects which are not seen when small apertures with the same focal length are employed? This superiority is particularly shown with test objects marked with grooves or ridges and obliquely illuminated. The marginal part of the lens will enlarge the grooves and ridges, and they will thus be rendered visible, not because they are seen more distinctly, but because they are expanded by the combination of their incoincident images. Hence we have an explanation of the fact—well known to all who use the microscope—that objects are seen more distinctly with object-glasses of small angular aperture. In the one case we have, with the same magnifying power, not only an enlarged and indistinct image of objects, but a false representation of them, from which their true structure cannot be discovered; while in the other we have a smaller and distinct image, and a more correct representation of the object. But these are not the only objections to large angular apertures and short focal lengths. 1. In the first place, it is extremely difficult to illuminate objects when so close to the object-glass. 2. There is a great loss of light, from its oblique incidence on the surface of the first lens. 3. The surface of glass,—with the most perfect polish,—must be covered with minute pores, produced by the attrition of the polishing powder; and light, falling upon the sides of these pores with extreme obliquity, must not only suffer diffraction, but be refracted less perfectly than when incident at a less angle. 4. When the object is almost in contact with the anterior lens, the microscope is wholly unfit for researches in which mechanical or chemical operations are required, and also for the examination of objects inclosed in minerals or other transparent bodies. 5. In object-glasses now in use, the rays of light must pass through a great thickness of glass of doubtless homogeneity. It is a question yet to be solved whether or not, a substance can be truly transparent, in which the elements are not united in definite proportion; in which the substances combined have very different refractive and dispersive powers; and in which the particles are so loosely united that they separate from one another, as in the various kinds of decomposition to which glass is liable. If the best microscopes are affected by these sources of error, every exertion should be made to diminish or remove them. 1. The first step, we conceive, is, to abandon large apertures, and to use object-glasses of moderate focal length, obtaining at the eye-glass any additional magnifying power that may be required. 2. In order to obtain a better illumination, either by light incident vertically or obliquely, a new form of the microscope would be advantageous. In place

of directing the microscope to the object itself, placed as it now is, almost touching the object-glass, let it be directed to an image of the object, formed by the thinnest achromatic lens, of such a focal length that the object may be an inch or more from the lens, and its image equal to, or greater, or less than the object. In this way the observer will be able to illuminate the object, whether opaque or transparent, and may subject it to any experiments he may desire to make upon it. It may thus be studied without a covering of glass, and when its parts are developed, by immersion in a fluid. 3. The sources of error arising from the want of perfect polish and perfect homogeneity of the glass of which the lenses are composed, are, to some extent, hypothetical; but there are reasons for believing,—and these reasons corroborated by facts,—that a body whose ingredients are united by fusion, and kept in a state of constraint from which they are striving to get free, cannot possess that homogeneity of structure, or that perfection of polish, which will allow the rays of light to be refracted and transmitted without injurious modification. If glass is to be used for the lenses of microscopes, long and careful annealing should be adopted, and the polishing process should be continued long after it appears perfect to the optician. We believe, however, that the time is not distant when transparent minerals, in which their elements are united in definite proportions, will be substituted for glass. Diamond, topaz, and rock crystal are those which appear best suited for lenses. The white topaz of New Holland is particularly fitted for optical purposes, as its double refractions may be removed by cutting it in plates perpendicular to one of its optical axes. In rock crystal the structure is, generally speaking, less perfect along the axis of double refraction than in any other direction, but this imperfection does not exist in topaz.—Prof. STOKES and Mr. STONEY suggested some modifications of Sir David Brewster's theoretic views; and a member of the Section whose name we did not catch, stated that several attempts had been made to form an image of objects more removed from the first or object-glass of the microscope than at psesent, by using an additional lens, but hitherto without success.—*Proc. Brit. Assoc.*, 1860.

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*On some Optical Illusions connected with the Inverson of Perspective.**

By Sir D. BREWSTER.

The term "Inversion of Perspective" has been applied to a class of optical illusions, well known and easily explained, in which depressions are turned into elevations, and elevations into depressions. One of the most remarkable cases of this kind, which has not yet been explained, presented itself to the late Lady Georgiana Wolf, and has been recorded by her husband, Dr. Wolf. When she was riding on a sand-beach in Egypt, all the foot-prints of horses appeared as elevations, in place of depressions, in the sand. No particulars are men-

* From the Lond. Athenæum, July, 1860.

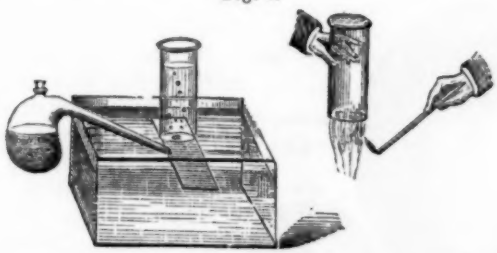
tioned, in reference to the place of the sun, or the nature of the surrounding objects, to enable us to form any conjecture respecting the cause of this phenomenon. Having often tried to see this illusion, I was some time ago so fortunate as not only to observe it myself, but to show it to others. In walking along the west sands of St. Andrew's, the foot-prints, both of men and of horses, appeared as elevations. In a short time they sank into depressions, and subsequently rose into elevations. The sun was at this time not very far from the horizon, on the right hand; and on the left there were large waves of the sea breaking into very bright foam. The only explanation which occurred to me was, that the illusion appeared when the observer supposed that the foot-prints were illuminated with the light of the breakers, and not by the sun. Having, however, more recently observed the phenomenon, when the sun was very high on the right, and the breakers on the left very distant, and consequently very faint, I could not consider the preceding explanation as well founded. Upon attending to the circumstances under which they were now seen, I observed that the human foot-prints were all covered with dry sand that had been blown into them, so that they were much brighter than the surrounding sand, and the dark side of the impression next the sun; and hence it is probable that they appeared to be nearer the eye than the dark sand in which they were formed, and consequently elevations. After repeated examinations of them, I found the foot-prints appeared as elevations as far as the eye could see them; and they were equally visible with one or both eyes. But whenever the eye rested for a little while on the nearest foot-print, it resumed its natural concavity. I have observed other illusions of this kind which are more easily explained, though they differ from any hitherto described. In the Church of Sant' Agostino in Rome, there is above each arch a painted festoon suspended on two short pillars; but, instead of appearing in relief, as the painter intended by shading one side of them, they appeared concave like an intaglio. In other positions in the church they rose into relief. Upon a subsequent visit to the church, I found that the festoon or suspended wreath was concave when it was illuminated—or rather when the observer saw that it was illuminated—by a window beneath it, and in relief when the eye saw that it was illuminated by a window above it, the object being similarly illuminated in both cases. In the common cases of inverted perspective, the eye is deceived by looking at the inversion of the shadow in the cameo or intaglio itself; but in the present case the eye is deceived by perceiving that the body-painting, supposed to be in relief, is illuminated by a light either above or below it. An optical illusion of a different kind presented itself to me in the Church of Santa Giustina at Padua. Upon entering the church we see three cupolas. The one beneath which we stood appeared very shallow; the next appeared much deeper, and the third deeper still. They were all, however, of the same depth, as we ascertained by placing ourselves under each in succession, and observing that it was always the shallowest.

A Course of Lectures, consisting of Illustrations of the Various Forces of Matter, i.e. *of such as are called the Physical or Inorganic Forces.** By M. FARADAY, D.C.L., F.R.S.

LECTURE IV. (Jan. 5, 1860.)—*Chemical Affinity.—Heat.*

We shall have to pay a little more attention to the forces existing in water before we can have a clear idea on the subject. Besides the attraction which there is between its particles to make it hold together as a liquid or a solid, there is also another force, different from the former;—one which, by means of the voltaic battery, we yesterday overcame, drawing from the water two different substances, which, when heated by means of the electric spark, attracted each other, and rushed into combination to reproduce water. Now, the best thing I can do to-day is to continue this subject, and trace the various phenomena of chemical affinity; and for this purpose, as we yesterday considered the character of oxygen, of which I have here two jars (oxygen being those particles derived from the water which enable other bodies to burn), we will now consider the other constituent of water, and without embarrassing you too much with the way in which these things are made, I will proceed now to show you our common way of making *hydrogen*. (I called it hydrogen yesterday—it is so called because it helps to generate water.)† I put into this retort some zinc, water, and oil of vitriol, and immediately an action takes place which produces an abundant evolution of gas now coming over into this jar, and bubbling up in appearance exactly like the oxygen we obtained yesterday.

Fig. 1.



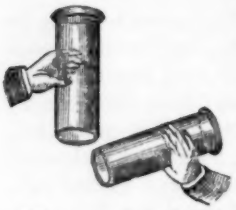
The processes, you see, are very different, though the result is the same in so far as it gives us certain gaseous particles. Here, then, is the hydrogen; I showed you yesterday certain qualities of this gas, now let me show you some other qualities. It is a combustible substance, not like the oxygen which is a supporter of combustion although it will not burn. There is a jar full of it, and if I carry it along in this manner and put a light to it, I think you will see it take fire, not with a bright light,—you will, at all events, hear it if you do not see it. Now, that is a body entirely different from oxygen; it is extremely light; for although you yesterday saw twice as much of this hydrogen produced on the one side as the other, by the voltaic battery, it was only one-eighth the weight of the oxygen. I carry this jar upside

* From the Lond. Chemical News, No. 8.

† ὑδωρ, "water," and γεννάω, "I generate."

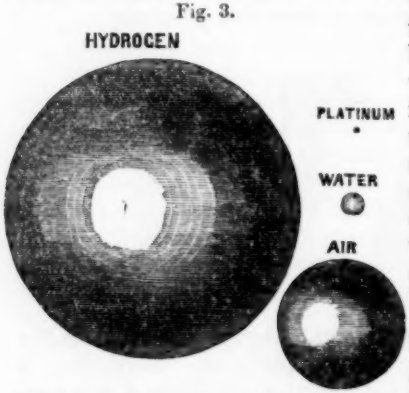
down. Why? Because I know that it is a very light body, and that it will continue in this jar upside down quite as effectually as the water will in that jar which is not upside down; and just as I can pour water from one vessel into another in the right position to receive it, so can I pour this gas from one jar into another when they are upside down. See what I am about to do,—there is no hydrogen in this jar at present, but I will gently turn this jar of hydrogen up under this other jar (Fig. 2) and then we will examine the two. We shall see, on applying a light, that the hydrogen has left the jar in which it was at first, and has poured upwards into the other, and there we shall find it.

Fig. 2.



You now understand that we can have particles of very different kinds, and that they can have different bulks and weights; and there are two or three very interesting experiments which serve to illustrate this. For instance, if I blow soap bubbles with the breath from my mouth you will see them fall, because I fill them with common air, and the water which forms the bubble carries it down. But now if I inhale hydrogen gas into my lungs (it does no harm to the lungs, although it does no good to them), see what happens. [The Lecturer inhaled some hydrogen, and after one or two ineffectual attempts, succeeded in blowing a splendid bubble, which rose majestically and slowly to the ceiling of the theatre, where it burst.] That shows you very well how light a substance this is; for notwithstanding all the heavy bad air from my lungs, and the weight of the bubble, you saw how it was carried up. I want you now to consider this phenomenon of weight as indicating how exceedingly different particles are one from the other; and I will take as illustrations these very common things, air, water, the heaviest body–platinum–and this gas, and observe how they differ in this respect; for if I take a piece of platinum of that size (Fig. 3) it is equal to the weight of portions of water, air, and hydrogen of the bulks I have represented in these spheres; and this illustration gives you a very good idea of the extraordinary difference with regard to the gravity of the articles having this enormous difference in bulk. [The following tabular statement having reference to this illustration appeared on the diagram board.]

Fig. 3.



Hydrogen, . .	1		
Air, . .	14·4	1	
Water, . .	11943	829	1
Platinum, . .	256774	17831	21·5

Whenever oxygen and hydrogen unite together they produce water, and you have seen the extraordinary difference between the bulk and appearance of the water so produced and the particles of which it consists chemically. Now we have never yet been able to reduce either oxygen or hydrogen to the liquid state; and yet their first impulse when chemically combined is to take up first this liquid condition and then the solid condition. We never combine these different particles together without producing water; and it is curious to think how often you must have made the experiment of combining oxygen and hydrogen to form water without knowing it. Take a candle, for instance, and a clean silver spoon (or a piece of clean tin will do), and if you hold it over the flame you immediately cover it with a dew—not a smoke—which presently evaporates. This perhaps will serve to show it better. Mr. Anderson will put a candle under that jar, and you will see how soon the water is produced (Fig. 4). Look at that dimness on the sides of the glass, which will soon produce drops and trickle down into the plate. Well, that dimness and these drops are *water*, formed by the union of the oxygen of the air with the hydrogen existing in the wax of which that candle is formed.

Fig. 4.

And now, having brought you in the first place to the consideration of chemical attraction, I must enlarge your ideas so as to include all substances which have this attraction for each other—for it changes the character of bodies, and alters them in this way and that way, in the most extraordinary manner; and produces other phenomena wonderful to think about. Here is some chlorate of potash, and there is some sulphuret of antimony. We will mix these two different sets of particles together, and I want to show you in a general sort of way, some of the phenomena which take place when we make different particles act together. Now I can make these bodies act upon each other in several ways. In this case I am going to apply heat to the mixture, but if I were to give it a blow with a hammer the same result would follow. [A lighted match was brought to the mixture, which immediately exploded with a sudden flash, evolving a dense white smoke.] There you see the result of the action of chemical affinity, overcoming the attraction of cohesion of the particles. Again, here is a little sugar, quite a different substance from the black sulphuret of antimony, and you shall see what takes place when we put the two together. [The mixture was touched with sulphuric acid, when it took fire and burnt gradually and with a brighter flame than in the former instance.] Observe this chemical affinity! traveling about the mass, and setting it on fire, and throwing it into such wonderful agitation.

I must now come to a few circumstances which require careful consideration. We have already examined one of the effects of this chemical affinity—but to make the matter more clear we must point out some others. And here are two salts dissolved in water. They are

both colorless solutions, and in these glasses you cannot see any difference between them. But if I mix them, I shall have chemical attraction take place. I will pour the two together into this glass, and you will at once see, I have no doubt, a certain amount of change. Look, they are already becoming milky, but they are sluggish in their action—not quick as the others were—for we have endless varieties of rapidity in chemical action. Now if I mix them together, and stir them so as to bring them properly together, you will soon see what a different result is produced. As I mix them they get thicker and thicker, and you see the liquid is hardening and stiffening, and before long I shall have it quite hard; and before the end of the lecture, it will be a solid stone—a wet stone no doubt, but more or less solid—in consequence of the chemical affinity. Is not this changing two liquids into a solid body a wonderful manifestation of chemical affinity?

There is another remarkable circumstance in chemical affinity, which is that it is capable of either waiting or acting at once. And this is very singular, because we know of nothing of the kind in the forces either of gravitation or cohesion. For instance, here are some oxygen particles, and here is a lump of carbon particles. I am going to put the carbon particles into the oxygen; they *can* act, but they *do* not—they are just like this unlighted candle. It stands here quietly on the table, waiting until we want to light it. But it is not so in this other case: here is a substance, gaseous like the oxygen, and if I put these particles of metal into it the two combine at once. The copper and the chlorine unite by their power of chemical affinity, and produce a body entirely unlike either of the substances used. And in this other case, it is not that there is any deficiency of affinity between the carbon and oxygen, for the moment I choose to put them in a condition to exert their affinity, you will see the difference. [The piece of charcoal was ignited, and introduced into the jar of oxygen, when the combustion proceeded with vivid scintillations.]

Now this chemical action is set going exactly as it would be if I had lighted the candle, or as it is when the servant put coals on and lights the fire: the substances wait until we do something which is able to start the action. Can any thing be more beautiful than this combustion of charcoal in oxygen? You must understand that each of these little sparks is a portion of the charcoal, or the bark of the charcoal, thrown off white-hot into the oxygen, and burning in it most brilliantly as you see. And now let me tell you another thing, or you will go away with a very imperfect notion of the powers and effects of this affinity. There you see some charcoal burning in oxygen. Well, a piece of lead will burn in oxygen just as well as the charcoal does, or indeed better, for absolutely that piece of lead will act at once upon the oxygen as the copper did in the other vessel with regard to the chlorine. And here also is a piece of iron; if I light it and put it into the oxygen, it will burn away just as the carbon did. And I will take some lead and show you that it will burn in the common atmospheric oxygen at the ordinary temperature. These are the lumps of lead which you remember we had the other day—the two pieces which clung

together. Now these pieces, if I take them to-day and press them together, will not stick, and the reason is that they have attracted from the atmosphere a part of the oxygen there present, and have become coated as with a varnish by the oxide of lead which is formed on the surface, by a real process of combustion or combination. There you see the iron burning very well in oxygen, and I will tell you the reason why those scissors and that lead do not take fire whilst they are lying on the table. Here the lead is in a lump, and the coating of oxide remains on its surface, whilst there you see the melted oxide is clearing itself off from the iron, and allowing more and more to go on burning. In this case, however [holding up a small glass tube containing lead pyrophorus], the lead has been very carefully produced in fine powder, and put into a glass tube and hermetically sealed so as to preserve it, and I expect you will see it take fire at once. This has been made about a month ago, and has thus had time enough to sink down to its normal temperature—what you see, therefore, is the result of chemical affinity alone. [The tube was broken at the end, and the lead poured out on to a piece of paper, whereupon it immediately took fire.] Look, look, at the lead burning, why it has set fire to the paper. Now that is nothing more than the common affinity always existing between very clean lead and the atmospheric oxygen; and the reason why this iron does not burn until it is made red-hot, is because it has got a coating of oxide about it which stops the action of the oxygen,—putting a varnish, as it were, upon its surface, as we varnish a picture—absolutely forming a substance which prevents the natural chemical affinity between the bodies from acting.

I must now take you a little further in this kind of illustration, or consideration I would rather call it, of chemical affinity. This attraction between different particles exists also most curiously in cases where they are previously combined with other substances. Here is a little chlorate of potash containing the oxygen which we found yesterday could be procured from it; it contains the oxygen there combined and held down by its chemical affinity with other things; but still it can combine with sugar, as you saw. This affinity can thus act *across* substances, and I want you to see how curiously what we call combustion acts with respect to this force of chemical affinity. Suppose I take a piece of phosphorus and set fire to it, and then place a jar of air over the phosphorus, you see the combustion which we are having there on account of chemical affinity (combustion being in all cases the result of chemical affinity). The phosphorus is escaping in that vapor, which will condense into a snow-like mass at the close of the lecture. But suppose I limit the atmosphere, what then? why, even the phosphorus will go out. Here is a piece of camphor which will burn very well in the atmosphere, and even on water it will float about and burn, by reason of some of it particles gaining access to the air. But if I limit the quantity of air by placing a jar over it, as I am now doing, you will soon find the camphor will go out. Well, why does it go out? not for want of air, for there is plenty of air remaining in the jar. Perhaps you will be shrewd enough to say for want of oxygen.

This therefore leads us to the inquiry as to whether oxygen can do more than a certain amount of work. The oxygen there (Fig. 4) cannot go on burning an unlimited quantity of candle, for that has gone out, as you see; and its amount of chemical attraction or affinity is just as strikingly limited; it can no more be fallen short or exceeded than can the attraction of gravitation. You might as soon attempt to destroy gravitation, or weight, or all things that exist, as to destroy the exact amount of force exerted by this oxygen. And when I pointed out to you that 8 by weight of oxygen to 1 by weight of hydrogen went to form water, I meant this, that neither of them would combine in different proportions with the other, for you cannot get 10 of hydrogen to combine with 6 of oxygen, or 10 of oxygen to combine with 6 of hydrogen—it must be 8 of oxygen and 1 of hydrogen. Now suppose I limit the action in this way: this piece of cotton-wool burns, as you see, very well in the atmosphere; and I have known of cases of cotton-mills being fired as if with gunpowder, through the very finely divided particles of cotton being diffused through the atmosphere in the mill, when it has sometimes happened that a flame has caught these raised particles, and it has run from one end of the mill to the other and blown it up. That, then, is on account of the affinity which the cotton has for the oxygen; but suppose I set fire to this piece of cotton which is rolled up tightly; it does not go on burning, because I have limited the supply of oxygen, and the inside is prevented from having access to the oxygen, just as it was in the case of the lead by the oxide. But here is some cotton which has been imbued with oxygen in a certain manner. I need not trouble you now with the way it is prepared; it is called gun-cotton. See how that burns [setting fire to a piece]; it is very different from the other, because the oxygen that must be present in its proper amount is put there beforehand. And I have here some pieces of paper which are prepared like the gun-cotton, and imbued with bodies containing oxygen. Here is some which has been soaked in nitrate of strontia—you will see the beautiful red color of its flame; and here is another which I think contains baryta, which gives that fine green light; and I have here some more which has been soaked in nitrate of copper,—it does not burn quite so brightly, but still very beautifully. In all these cases the combustion goes on independent of the oxygen of the atmosphere. And here we have some gunpowder put into a case, in order to show that it is capable of burning under water. You know that we put it into a gun, shutting off the atmosphere with shot, and yet the oxygen which it contains supplies the particles with that without which chemical action could not proceed. Now I have a vessel of water here, and am going to make the experiment of putting this fuse under the water, and you will see whether that water can extinguish it; here it is burning out of the water, and there it is burning under the water, and so it will continue until exhausted, and by reason of the requisite amount of oxygen being contained within the substance. It is by this kind of attraction of the different particles one to the other that we are enabled to trace the laws of chemical affinity, and the wonderful variety of the exertions of these laws.

Now I want you to observe that one great exertion of this power which is known as *chemical affinity* is to produce HEAT and light; you know as a matter of fact, no doubt, that when bodies burn they give out heat, but it is a curious thing that this heat does not continue—the heat goes away as soon as the action stops, and you see by that that it depends upon the action *during the time* it is going on. That is not so with gravitation; this force is continuous, and is just as effective in making that lead press on the table as it was when it first fell there. Nothing occurs there which disappears when the action of falling is over; the pressure is upon the table, and will remain there until the lead is removed; whereas, in the action of chemical affinity to give light and heat, they go away immediately the action is over. This lamp *seems* to evolve heat and light continuously, but it is owing to a constant stream of air coming into it on all sides, and this work of producing light and heat by chemical affinity will subside as soon as the stream of air is interrupted. What, then, is this curious condition of heat? Why it is the evolution of another power of matter, of a power new to us, and which we must now consider as if it were the very first time it was brought under our notice. What is heat? We recognise heat by its power of liquefying solid bodies and vaporizing liquid bodies, by its power of setting chemical affinity going and very often overcoming it. Then how do we obtain heat? We obtain it in various ways; most abundantly by means of the chemical affinity we have just before been speaking about, but we can also obtain it in many other ways. Friction will produce heat. The Indians rub pieces of wood together until they get them hot enough to take fire, and such things have been known as two branches of a tree rubbing together so hard as to set the tree on fire. I do not suppose I shall set these two pieces of wood on fire by friction; but I can readily produced heat enough to ignite some phosphorus. [The Lecturer here rubbed two pieces of cedar wood strongly against each other for a minute, and then placed on them a piece of phosphorus, which immediately took fire.] And if you take a smooth metal button stuck on a cork, and rub it on a piece of soft deal wood, you will make it so hot as to scorch wood and paper, and burn a match.

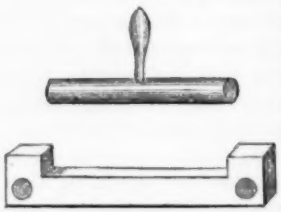
Fig. 5.

I am now going to show you that we can obtain heat not by chemical affinity alone, but by the pressure of air. Suppose I take a pellet of cotton and moisten it with a little ether, and put it into a glass tube (Fig. 5), and then take a piston and press it down suddenly, I expect I shall be able to burn a little of that ether in the vessel. It wants a suddenness of pressure or we shall not do what we require. [The piston was forcibly pressed down, when a flame due to the combustion of the ether was visible in the lower part of the syringe.] All we want is to get a little ether in vapor, and give fresh air each time, and so we may go on again and again getting heat enough by the compression of air to fire the vapor of ether.

This, then, I think, will be enough, accompanied with all you have previously seen, to show you how we procure heat. And now for the

effects of this power. We need not consider many of them on the present occasion, because when you have seen its power of changing ice into water and water into steam, you have seen the two principal results of the application of heat. I want you now to see how it expands all bodies—all bodies but one, and that under limited circumstances. Mr. Anderson will hold a lamp under that retort, and you will see the moment he does so that the air will issue abundantly from the neck which is under water, because the heat which he applies to the air causes it to expand. And here is a brass rod (Fig. 6) which goes through that hole and also fits accurately into this gauge; but if I make it warm with this spirit-lamp it will only go in the gauge or through the hole with difficulty; and if I were to put it into boiling water it would not go through at all. Again: as soon as the heat leaves bodies they collapse; see how the air is contracting in the vessel now Mr. Anderson has taken away his lamp; the stem of it is filling with water. And notice now that although I cannot get the tube through this hole or into the gauge, the moment I cool it by dipping it into water, it goes through with perfect facility, so that you see we have a perfect proof of this power of heat to contract and expand bodies.

Fig. 6.



(To be Continued.)

Specification of a Patent granted to FREDERICK AUGUSTUS ABEL *for Improvements in Protecting from Fire, Textile Materials in the Raw or in the Manufactured State.**—[Dated 23d December, 1859.]

The improvements forming the subject of this invention consist in affording protection against fire to textile materials in the raw or in the manufactured state, by impregnating such materials with insoluble metallic silicates within the fibre of the material.

The process by which this is effected is as follows:—Prepare a solution of lead, of zinc, or, practically speaking, of any other metallic base capable of forming, by its action upon a soluble silicate, a double silicate, insoluble in water, and, by preference, a basic acetate of lead, prepared, as is well known, by boiling sugar of lead and litharge with water. It has been found that solutions of various strengths will answer the purpose, yet the one preferred is prepared by boiling together twenty-five pounds of sugar of lead, fifteen pounds of litharge, and forty gallons of water, for about half an hour, and allowing the same to stand for about a couple of hours; the decanted clear solution forms a liquor well adapted to the purpose of the patentee.

To use the liquor so prepared, and which, in the present instance, is a solution of basic acetate of lead, the patentee takes such a quantity of it as will be at least sufficient to cover completely the fabric or material intended to be made uninflammable, or else the fabric or material may, in many cases, be simply passed through the liquid, raised to nearly the boiling point; the object being simply to saturate or im-

*From Newton's London Journal, August, 1860.

pregnate it thoroughly with the liquor. This having been done, the fabric so saturated with the liquor is to be removed, and spread out for about twelve hours to the contact of the air. This hanging out of the fabric or material to the air may be dispensed with, but it is preferred to do so, the subsequent operation now to be described yielding then a better result.

The fabric, after having been subjected to the first operation just described, should now be immersed for a period of from one to two hours, or thereabouts, in a hot and moderately strong solution of an alkaline silicate, by preference, in silicate of soda. It should then be withdrawn from the bath of alkaline silicate, allowed to drain, washed thoroughly in soft water, and dried; when it will be found to have acquired the properties claimed for it.

The patentee does not confine himself to the use of any particular silicate, or of any metallic salt, nor to the precise *modus operandi* described; but he claims, "protecting from fire textile materials in the raw or in the manufactured state, by the production of an insoluble silicate within the fibre or texture of the said textile materials.

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*On the means of Increasing the Angle of Binocular Instruments, in order to obtain a Stereoscopic Effect in proportion to their Magnifying Power.** By Mr. A. CLAUDET.

In a paper on the stereoscope, which Mr. Claudet read before the Society of Arts in the year 1852, alluding to the reduction of the stereoscopic effect produced by opera-glasses on account of their magnifying power, he stated that, in order to reduce that defect, it would be necessary to increase the angle of the two perspectives. This he proposed to do by adapting to the object-glasses two sets of reflecting prisms, which by the greater separation given to the two lines of perspectives, would reflect on the optic axes images taken at a greater angle than the angle of natural vision. Such was the instrument that Mr. Claudet submitted to the British Association, to prove, as he has always endeavored to demonstrate in various memoirs, that the binocular angle of stereoscopic pictures must be in proportion to the ultimate size of the pictures on the retina, larger than the natural angle when the images are magnified, and smaller when they are diminished; which, in fact, is nothing more than to give or restore to these images the natural angle at which the objects are seen when we approach them or recede from them. For magnifying or diminishing the size of objects is the same thing as approaching them or receding from them, and in these cases the angles of perspectives cannot be the same. Mr. Claudet showed that, looking at the various rows of persons composing the audience with the large ends of the opera-glass, all the various rows appeared too close to one another, that there was not between them the distance which separates them when we look with the eyes alone; and he showed also that, with the small end, the distance appeared considerably exaggerated. But, applying the sets of prisms to the opera-glass in order to increase the an-

* From the London Athenæum, July, 1860.

gle of the two perspectives, then looking at the audience as before, it appeared that the various rows of persons had between them the natural distance expected for the size of the image or for the reduction of the distance of the objects. By applying the two sets of prisms before the eyes without the opera-glass, it was observed, as was to be expected, that the stereoscopic effect was considerably exaggerated, because the binocular angle was increased without magnifying the objects. But looking with the two sets of prisms alone at distant objects, the exaggeration of perspective did not produce an unpleasant effect. It appeared as if we were looking at a small model of the objects brought near the observer. By the same reason, stereoscopic pictures of distant objects (avoiding to include in them near objects) can advantageously be taken at a larger angle than the natural angle, in order to give them the relief of which they are deprived as much when we look at them with the eyes, as when we look only with one eye; instead of being a defect, it seems that it is an improvement. In fact, the stereoscope gives us two eyes to see pictures of distant objects.—*Proc. Brit. Assoc.*, 1860.

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*On the Principles of the Solar Camera.** By A. CLAUDET.

The solar camera invented by Woodward, is one of the most important improvements introduced in the art of photography since its discovery. By its means, small negatives may produce pictures magnified to any extent; a portrait taken on a collodion plate not larger than a visiting-card, can be increased, in the greatest perfection, to the size of nature; views as small as those for the stereoscope can be also considerably enlarged. This is an immense advantage, which is easily understood when we consider how much quicker and in better proportion of perspective small pictures are taken by the camera obscura, while the manipulation is so greatly simplified. There is nothing new in the enlargement of photographic pictures. This has been done long ago simply by attending to the law of conjugate foci; and every photographer has always been enabled, with his common camera, to increase or reduce the size of any image. For the enlargement, it was only necessary to place the original very near the camera, and to increase in proportion the focal distance. But the more the focal distance was increased, the more the intensity of light was reduced; and a still greater loss of light arose from the necessity of diminishing the aperture of the lens, in order to avoid the spherical aberration. Such conditions rendered the operation so long that it became almost an impossibility to produce any satisfactory results when the picture was to be considerably enlarged. For these reasons, it naturally occurred that if the negative, having its shadows perfectly transparent and its lights quite black, was turned against the strong light of the sun, its positive image at the focus of the camera would be so intense that the time of exposure would be considerably reduced. So that, in order to employ the light of the sun, and follow easily its position without having to move constantly the whole camera, it was

*From the London Athenæum, July, 1860.

thought advisable to employ a movable reflecting mirror, sending the parallel rays of the sun on a vertical plano-convex lens condensing those rays on the negative, placed before the object glass and behind the condenser, somewhere in its luminous cone. Many contrivances for this object were resorted to, but without considering any thing else than throwing the strongest light possible on the negative to be copied. The constructors of these solar cameras never thought it very important to consider whether the focus of the condensing lens was better to fall before or behind the front of the object glass, provided the negative was placed in the luminous cone of the condenser. This want of attention has been the cause which has made the solar camera a very imperfect instrument for copying negatives. The beautiful principle of Woodward's apparatus consists in his having decided the question of the position of the focus of the condenser, and in having placed it exactly on the front lens of the camera obscura. As this principle had not yet been explained when the invention was exhibited before the Photographic Societies of London and Paris, and not even by the inventor himself in the specification of his patent, Mr. Claudet has undertaken, in the interest of the photographic art, to bring the subject before the British Association, and to demonstrate that the solar camera of Woodward has solved the most difficult problem of the optics of photography, and is capable of producing wonderful results. This problem consists in forming the image of the negative to be copied only by the centre of the object-glass reduced to the smallest aperture possible, without losing the least proportion of the light illuminating the negative. The solar camera does not require any diaphragm to reduce the aperture of the lens, because every one of the points of the negative are visible only when they are defined on the image of the sun, and they are so (in that position exclusively), for the centre of the lens is the only point which sees the sun, while the various points of the negative which form the marginal zone of the lens, are defined against the comparatively obscure parts of the sky surrounding the sun, are, as it were, invisible to that zone; so that the image is produced only by the central rays, and not in the least degree by any other points of the lens, which are subject to spherical aberration. It is, in fact, a lens reduced to an aperture as small as is the image of the sun upon its surface, without the necessity of any diaphragm, and admitting the whole light of the sun after it has been condensed upon the various separate points of the negative. It is evident that, from the centre of the lens the whole negative has for background the sun itself, and from the other points of the lens it has for background only the sky surrounding the sun, which fortunately has no effect in the formation of the image. Such is the essential principle of Woodward's solar camera, which did not exist in that instrument when the focus of the condenser was not on the object-glass. This principle is truly marvellous, but it must be observed that the solar camera, precisely on account of the excellence of this principle, requires the greatest precision in its construction. For its delicate performances, it must be as perfect as an astronomi-

cal instrument, which, in fact, it is. The reflecting mirror should be plane, and with parallel surfaces, in order to reflect on the condenser an image of the sun without deformation; and in order to keep the image always on the very centre of the object-glass, the only condition for the exclusion of the oblique rays, the mirror should be capable by its connexion with a heliostat of following the movements of the sun. The condenser itself should be achromatic, in order to refract the image of the sun without dispersion, and to define more correctly the lines of the negative; and a no less important condition for losing nothing of the photogenic rays would be, to have it formed with a glass perfectly homogeneous and colorless. With such improvements, the solar camera will become capable of producing results of the greatest beauty; and, without any question, its introduction into the photographer's studio will mark a period of considerable improvement in the art.—*Proc. Brit. Assoc.*, 1860.

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*On the Perception of Colors.** By Dr. GLADSTONE.

The author described himself as in an intermediate position between those who have a normal vision of colors, and those who are termed "color-blind." These latter are usually unacquainted with the sensations of either red or green, and it becomes a desideratum to have good observations on those who are capable of acting somewhat as interpreters between them and those who perceive every color. By means of Chevreul's chromatic circles and scales, Maxwell's color-top, colored beads, &c., the author was able to determine the following points in respect to his own vision. He sees red, in all probability, like other people, but it requires a larger quantity of the color to give the sensation than is usually the case; hence a purple appears to him more blue, and an orange more yellow, than to the generality of observers. He is perfectly sensible of green, or rather of two distinct greens,—the one yellowish, the other blueish,—but between them there lies a particular shade of green, to which his eyes are insensible as a color. This modifies his perception of many greens that approximate to what is to him invisible. The shade occurs in nature on the back of the leaf of the variegated holly, and it may be produced in Maxwell's top by certain combinations of the colored disc; the simplest being:—

94·5 Brunswick Green (Blue Shade) + 5·5 Ultramarine = 94 Black + 6 White.

While able perfectly to distinguish between red and green, the contrast does not readily catch his eye, especially at a distance; in fact, he is somewhat short-sighted in respect to these colors. He has reason to believe that, in his case, there has been a gradual improvement in his actual perception of colors, independently of his greater knowledge of them, though this is in opposition to the general experience of those whose vision is in any way abnormal, and no other instance was known to the late Prof. George Wilson, whose book is the standard one on the subject of color-blindness.

* From the London Athenæum, July, 1860.

*On the Use of Granite.** By Gardner Wilkinson.

As the question of using granite for building and monumental purposes has been much discussed, I beg to offer a few remarks connected with it, and to notice a fact which shows at how early a period the ancient Egyptians had watched the effect of atmospheric and other influences on stone, and how wisely they profited by the lessons taught them by experience. They had learnt that earth, abounding with nitre, from its attracting moisture, had the effect of decomposing granite, but that in the dry climate of Upper Egypt the stone remained for ages uninjured when raised above all contact with the ground. When, therefore, there was a possibility of its being exposed to damp, they based an obelisk, or other granite monument, on limestone substructions; and these last are found to the present day perfectly preserved, while the granite above them gives signs of decay in proportion to its contact with the earth subsequently accumulated about it. I am speaking of Upper Egypt, visited only four or five times in a year by a shower of rain; for in the Delta granite remains have been affected in a far greater degree than in the Thebaïd. Nitre abounds there, and it is remarkable that the obelisks at Alexandria have suffered least on the sides next the sea.

The Egyptians seldom used granite as a building stone, except for a small sanctuary in some sandstone temple; and in the later times of the Ptolemies one or two temples were built entirely of granite. But in the pure Egyptian period, that stone was chiefly confined to the external and internal casing of walls, to obelisks, doorways, monolithic shrines, sarcophagi, statues, small columns, and monuments of limited size, and was sometimes employed for roofing a chamber in a tomb.

The durability of granite varies according to its qualities. The felspar is the first of its component parts which decompose, and its greater or less aptitude for decay depends on the nature of the base of which the felspar consists. Egypt produces a great variety of granite, and the primitive ranges in the desert, east of the Nile, about 35 miles from the Red Sea, supplied the Romans, with numerous hitherto unknown kinds, as well as with porphyry, which they quarried so extensively in that district; but the granite of the ancient Egyptians came from the quarries of Syene, in the valley of the Nile, and from these they obtained what was used for their monuments. It is from this locality that the name of "Syenite" has been applied to a certain kind of granite; it is, however, far from being all of the same nature, and a small portion of the stone found there is really what we now call "Syenite."

Already, at the early period of the third and fourth dynasties, between twelve and thirteen centuries before the Christian era, the Egyptians extensively employed granite for various purposes. They had learnt to cut it with such skill that the joints of the blocks were fitted with the utmost precision. Deep grooves were formed in the hard stone with evident facility; and it must have been known to them for a long period before the erection of the oldest monuments that re-

*From the London Builder, No. 907.

main—the Pyramids of Memphis, where granite was introduced in a manner which could only result from long experience. Again, in the time of the first Osirtasen, about 2050 B. C., granite obelisks were erected at Heliopolis, and in the Fyoóm, and other granite monuments were raised in the same reign at Thebes; from which we find that even then the Egyptians had learnt how the damp earth acted on granite when buried beneath it; and this interesting question subsequently suggests itself—how long before that time must the stone have been used to enable them to obtain from experience that important hint which led them to place granite on limestone substructions?

I have already had occasion to offer some remarks on the mode of treating granite surfaces, which has been so ably detailed by Mr. Bell, at the meeting of the Society of Arts (March 14); and I have stated that the Egyptians adopted the broad character of ornamentation in sculpturing granite very judiciously advocated by him. I will, therefore, only add, that other good examples of such treatment may be found in early crosses of Cornwall, Devonshire, and other localities in this country; where what has been (rather hastily) called the Runic knot,—a design of entwined basket-work, common also in Italy, and other countries,—the large scroll pattern also frequently met with on the same monuments, and numerous massive ornaments in relieved intaglio, cut in the thickness of the stone are instances of a style of decorative sculpture admirably suited to granite.

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*Great Achievement of Mechanical Ingenuity.**

There is now to be seen at Bennett's, the well-known watch manufacturer of Cheapside, a gold hunting-watch of so remarkable a character as to well deserve description in our columns. In addition to being a time-keeper of the utmost precision, with chronometer adjustments, compensation balance, and cylindrical spring, it exhibits on the dial-plate the following different indications: first, the equation of time; secondly, the moon's age; thirdly, the month of the year; fourthly, the day of the month, in addition to the hours, minutes, and seconds, as in an ordinary watch. The mechanism is so contrived that any one or the whole of the hands may be set forwards or backwards at pleasure without deranging the rest. Mr. Bennett, the manufacturer of this remarkable production, naturally regards it as one of the highest triumphs of modern horological science; for these extraordinary time-keepers have hitherto been considered rather as mechanical marvels than as of practical use. In this case every movement is laid down in the strictest proportion, and based upon calculations of an absolutely scientific character. Although it has taken more than a twelve-month in its production, and is inclosed in a handsome gold case, it is within the compass of a pocket time-keeper. We strongly recommend those of our readers interested in mechanical science, to avail themselves of the opportunity of gratifying their curiosity as to what is possible to be effected by the enterprise of one of our leading watch manufacturers.

* From the Lond. Mechanics' Mag., June, 1860.

*On a New Form of Chloride of Sodium.** By Richard V. Tuson, Lecturer on Chemistry at Charing Cross Hospital.

That chloride of potassium, which ordinarily crystallizes in cubes is nevertheless often found as an efflorescence on various vegetable extracts assuming the acicular form is well known.

Hitherto, I believe, the corresponding compound, chloride of sodium, has never been observed in needle-shaped crystals but nearly always in cubes.

Occasionally, however, it deposits from urine in octahedra, and when a solution of the salt in water is evaporated at a temperature not exceeding 14° F. it crystallizes in hexagonal tables (Ehrenberg) which contain, according to Fuchs, six equivalents, but, according to Mitscherlich, four equivalents of water of crystallization. At temperatures above 14° F. these hexagonal crystals lose their water of crystallization and are resolved into a congeries of minute cubes. Chloride of sodium, it is also stated, may be obtained in large oblique rhombic prisms having the formula $NaCl + 4Ag$. They effloresce in air below 32° F. (Mitscherlich), deliquesce (? effloresce) in air above 32° F. (Fuchs), and leave a powder of small tubes.

Lately on opening a tightly-fitting tin box, in which a quantity of salmon-roe paste had been allowed to remain for nearly three years, it was found that the organic matter was covered by an efflorescence of acicular crystals. One of my pupils collected some of these crystals, analyzed them, and pronounced them to consist entirely of chloride of sodium. As I had never heard of chloride of sodium crystallizing in needles, their examination was repeated, but still the same results were obtained. Some of the crystals were next dissolved in water, and the solution produced submitted to spontaneous evaporation, when the whole of the salt deposited in the ordinary or cubical form. This result, therefore, fully confirms the conclusions deduced from analysis.

The crystals, some of which are nearly half an inch long, appear to be rectangular prisms terminated by four-sided pyramids. They are beautifully clear, colorless, transparent, elastic, longitudinally and transversely striated, and many are bent or contorted in a manner similar to the native hydrated sulphate of lime called selenite by mineralogists.

The acicular crystals are anhydrous and undergo no change in form or diminution in transparency when exposed to air at ordinary temperatures, or even at a low red heat. The needles of chloride of sodium possess one property which is a very familiar characteristic of the cubical salt, namely, that when heated they decrepitate. It is singular to remark, that, at all events as far as we know at present, the acicular varieties of the chlorides of potassium and of sodium are only developed in the presence of organic matter, just as the production of octahedral chloride of sodium appears to be due to the solution from which it crystallizes containing urea.

Since writing the foregoing, I have observed an efflorescence of

* From the Lond. Chemical News, No. 34.

acicular chloride of sodium on an animal deposit which was sent me for analysis, and which had been originally mixed with a solution of common salt to prevent it undergoing putrefaction.

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*A New Kind of Bath.**

M. Mathieu (de la Drôme) one of the most eminent orators of the "Mountain" in the National Assemblies of 1848 and 1849, has lately been turning his attention to the subject of medicinal baths. A bath by immersion requires from two to three hectolitres of water, which, in the case of mere river or spring water, is of no consequence as regards expense. But the case is far different when the water is to be impregnated with medicinal substances, some of which are very costly; or when mineral waters are prescribed, which cannot be had in large quantities without considerable outlay, except at the spring from which they are derived. M. Mathieu (de la Drôme) has therefore endeavored to ascertain, both by calculation and experiment, what is the real quantity of water which produces a useful effect on a human body in a common bath, and has found that it cannot be more than three or four litres in the course of an hour. To distribute this quantity both equally and economically on the body was, therefore, the question to be solved; and he has accordingly invented an apparatus, which he calls *bain hydrofère*. The patient is seated in a kind of box like that used for fumigation, while a powerful ventilator outside transforms the water which is to be used into a minute aqueous dust or dew, just as we see a high wind do with the water issuing from the jets of a monumental fountain. This dew is driven into the box through an aperture on a level with the knees; owing to the extreme minuteness of its particles, the latter ascend, and then gradually subside on the body. In a short time these particles coalesce and trickle down the body, until at last the water descends in an unceasing stream. This system has now been tried with great success at the Hôpital St. Louis, and is now generally attracting the attention of medical men.

*From the London Engineer, No. 232.

The Specific Gravity of Mixtures of Alcohol and Water.†

After three series of determinations which have occupied him more than a year, H. von Baumhauer has arrived at the conviction that the specific gravities of mixtures of alcohol and water, as determined by Gilpin, Löwitz, and Gay-Lussac, are very incorrect. In the first series of experiments the mixtures were made by volume, but as these gave results so different from those generally received, the author repeated his experiments with mixtures made by weight as well as by measure. These, however, only confirmed the results previously obtained. The author started with absolute alcohol having a sp. gr. of 0·7946 at 59° F. In the second series, alcohol from another source was used, which had the sp. gr. 0·7947 at the same temperature. The water used in the experiments was distilled and carefully deprived of

†From the Lond. Chemical News, No. 18.

air. After corrections for slight mistakes, the results obtained were as follows:—

Alcohol in 100 of the mixture.	1st Series.	2d Series.
100	0·7939	0·7940
95	0·8119	0·8121
90	0·8283	0·8283
85	0·8438	0·8432
80	0·8576	0·8572
75	0·8708	0·8708
70	0·8837	0·8938
65	0·8959	0·8963
60	0·9079	0·9081
55	0·9193	0·9196
50	0·9301	0·9302
45	0·9394	0·9400
40	0·9485	0·9491
35	0·9567	0·9569
30	0·9635	0·9636
25	0·9692	0·9696
20	0·9746	0·9747
15	0·9799	0·9800
10	0·9855	0·9855
5	0·9919	0·9918
0	0·9991	0·9991

*The Green Coloring Matter of Leaves.**

M. Frémy has also studied the constitution and composition of chlorophyll, which he supposes to be made up of two coloring matters, a blue and yellow, the first of which he names *phyllocyanine*, and the second *phylloxanthine*. M. Frémy discovered that by the action of some bases the green matter of leaves is changed to a beautiful yellow substance, which is easily dissolved by alcohol. In this solution, hydrochloric and some other acids will immediately restore the primitive green color. To separate the blue and yellow matters, M. Frémy proceeded as follows:—He first placed in a stoppered bottle two parts of ether and one part of hydrochloric acid, diluted with a little water, and then shook the bottle strongly for some time. He then submitted to the action of this liquid the body produced by the decolorization of the chlorophyll, shaking them together for some seconds. The effect was very remarkable. The ether dissolved the yellow matter of the leaves and became of a beautiful yellow color, while the hydrochloric acid reacted upon the green matter which had been decolorized, and produced a magnificent blue. The two colors are thus isolated, and, being retained by two different liquids, cannot be mixed to reproduce the green; but if the liquids are separated and the coloring matters withdrawn from them, solution in alcohol, which dissolves both, gives immediately a green tint comparable to that of the original chlorophyll. M. Frémy entertains some reasonable doubts whether his phyllocyanine and phylloxanthine really exist in vegetables,

* From the London Chemical News, No. 19.

and proposes to continue and extend his investigations on the subject. The whole subject is very interesting, and deserves a longer notice than we can give in this correspondence.

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*Vegetable Coloring Matters.**

M. Filhol has been engaged in the examination of vegetable coloring matters, and has discovered some facts which he now publishes as briefly as possible, intending to give all the details in a longer memoir. There exists in nearly all flowers, says M. Filhol, a substance which is scarcely colored when in solution in acid liquids, but which becomes of a beautiful yellow color when acted on by alkalies. This substance has the following properties. It is solid and of a slightly greenish-yellow color. It is uncrystallizable, soluble in water, alcohol, and ether, and not volatile. When moistened with strong hydrochloric acid, it takes a bright yellow tint which immediately disappears when the mixture is diluted with water, leaving an almost colorless solution to which alkalies communicate a yellow color. The matter is found in the green parts of plants as well as the flowers, and is, no doubt, the yellow dye found in the leaves of various plants. M. Filhol adopts the name given to it by Hope, and calls it *Xanthogene*. Mosses, he says, do not contain it, or, at most, only a trace. It is also absent from some flowers, among others the *Pelargonium Zonale*, and *inquinans Papaver rheas*, Camellias and Salvias. These flowers under the influence of alkalies become blue or violet without the least mixture of green. The coloring matter of these flowers is much less alterable under the influence of air and alkalies than that of most other flowers.

Chemists who have examined yellow flowers, have proved that they owe their color to several immediate principles; among others, *xanthine* and *xantheine*. The author has discovered *xanthine* in fruits as well as flowers.

* From the Lond. Chemical News, No. 19.

On the Density of Saturated Steam, and on the Law of Expansion for Superheated Steam.† By William Fairbairn, F.R.S.

At the last meeting of the British Association, I detailed a new method of ascertaining the specific gravity of vapors, which, in conjunction with my friend Mr. Tate, I was employing with a view to ascertain the density of steam at all temperatures. It may be of interest to the Association to know, that I believe the method to have proved itself reliable, and that we have now experimental determinations of the density of steam; and these fully verify the anticipations of Mr. Thomson and Mr. Rankine, that the vapor of water does not accurately obey the gaseous laws. We have found the density of saturated steam always greater than that given by the gaseous steam, even for temperatures as low as 136° Fah., and for pressures less than that of the atmosphere.

† From the Lond. Civ. Eng. and Arch. Journal, Aug., 1860.

The experiments as they stand at present extend over a range of temperature from 136° to 292° Fah., or from 2·6 to 60 lbs. pressure per square inch. But as we hope to extend them to higher pressures, I have preferred to leave at present the consideration of their bearing on other formulæ, and the ultimate generalizations to which they may lead in regard to the use of steam. The following simple formula, however, very nearly expresses the results of the experiments as to the density and pressure of saturated steam, the relation between pressure and temperature having been already determined with scrupulous accuracy by the elaborate investigations of Regnault.

Let v be the specific volume of the steam, or volume as compared with that of an equal weight of water; p = the pressure in inches of mercury. Then I find

$$v = 25{\cdot}62 + \frac{49513}{p + {\cdot}72}.$$

Table of Results, showing the Relation of Density and Pressure of Saturated Steam.

No.	Pressure.		Temperature, Fahrenheit.	Specific volume.		Proportional error of formula.
	In lbs. per square inch.	In inches of mercury.		From experiment.	By formula.	
1	2·6	5·35	136·77	8266	8183	+ 1–100
2	4·3	8·62	155 33	5326	5326	0
3	4·7	9·45	159·36	4914	4900	— 1–350
4	6·2	12·47	170·92	3717	3766	+ 1–74
5	6·3	12·61	171·48	3710	3740	+ 1–123
6	6·8	13·62	174 92	3433	3478	+ 1–76
7	8·0	16 01	182·30	3046	2985	— 1–50
8	9·1	18·36	188·30	2620	2620	0
9	11·3	22·88	198·78	2146	2124	— 1–97
1	26·5	53 61	242·90	941	937	— 1–235
2	27 4	55·52	244 82	906	906	0
3	27·6	55·89	245·22	891	900	+ 1–100
4	33·1	66·84	255·50	758	758	0
5	37·8	76·20	263·14	648	669	+ 1–32
6	40·3	81·53	267·21	634	628	— 1–100
7	41·7	84·20	269·20	604	608	+ 1–150
8	45·7	92·23	274·76	583	562	— 1–29
9	49·4	99·60	279·42	514	519	+ 1–100
11	51·7	104·54	282·58	496	496	0
12	55·9	112·78	287·25	457	461	+ 1–114
13	60 6	122·25	292 53	432	428	— 1–108
14	56·7	114 25	288 25	448	456	+ 1–56

The above table exhibits accurately the results at which we have arrived in regard to saturated steam; we have also obtained some results on the rate of expansion of superheated steam. These results are at present less complete than those upon saturated steam, as they do not range more than 20 degrees of temperature in each case above the maximum temperature of saturation. They appear, however, to show conclusively, that near the saturation point steam expands very

irrregularly, thus agreeing with what we know of other bodies in their physical relations at or near the point at which they change their state of aggregation. Close to the saturation point we find a very high rate of expansion, but this rapidly declines as the steam superheats, and at no great distance above it the rate of expansion nearly approximates to that of a perfect gas.

Thus, for instance, in Experiment 6, where the point of maximum saturation was 174·92, between this and 180° the steam expanded at the rate of $\frac{1}{190}$, whereas air would have expanded $\frac{1}{634}$; but on continuing the superheating, the co-efficient was reduced between 180° and 200° from $\frac{1}{190}$ to $\frac{1}{627}$, and for air the co-efficient would have been $\frac{1}{639}$, or almost exactly the same: and this rule holds good in every experiment; a high rate of expansion close to the saturation point diminishing rapidly to an approximation to that of air.

AMERICAN PATENTS.

AMERICAN PATENTS ISSUED FROM JULY 1, TO JULY 31, 1860.

Air or Gases,—Exhausting	R. W. Sievier,	U. Holloway,	Engl'd,	17
Anchors,—Appa's for Working	Angus Campbell,	Jersey City,	N. J.	3
Aniline Colors,—Preparation of	Joseph Renard,	Lyons,	France,	31
Awning Fixtures,	Edward Peach,	Utica,	N. Y.	31
Axe Helves,—Metal Cap for	A. W. Porter	St. Johnsville,	Vt.	17
Axles,—Car	Wm. Phelps,	Sycamore,	Ill.	3
Axletrees,—Setting	Arvin & Perkins,	Valparaiso,	Ind.	17
Bandages,—Catamenial	Dahis & Doermer,	Brooklyn,	N. Y.	31
Battery,—Chain Shot	C. B. Thayer,	Boston,	Mass.	24
Bed and Chair,—Combined	G. A. Keene,	Lynn,	"	3
Bed Cord,	Stephen Albro,	Buffalo,	N. Y.	3
Bedstead,—Secretary	George Gage,	Kendall's Mills,	Me.	24
Bee-hives,	Nathan Brasher,	Green Fork,	Ind.	31
———	Matthias M'Gonnigle,	Alleghany,	Penna.	31
Belt Lacing	H. A. Alden,	Matteawan,	N. Y.	31
Bench Hook,	Russel Frisbie,	Middletown,	Conn.	10
Bending Wood,—Machine for	Seidle & Eberly,	Mechanicsburg,	Penna.	10
Blind Slat Machine,	Johnson & Doyle,	Wetumpka,	Ala.	31
Boat-lowering Apparatus,	Flowers & Patton,	Bangor,	Me.	24
Bone Black,—Washing	Chas. Kinzler,	City of	N. Y.	10
Boots and Shoes,	N. C. Lewis, Jr.,	Boston,	Mass.	24
———,—Heel for	D. E. Somes,	Biddeford,	Me.	24
Bowls,—Making Wooden	Simonds & Goodspeed,	Ludlow,	Vt.	31
Brake,—Horse-power	Harvey & Becker,	Amsterdam,	N. Y.	24
Brake,—Self-acting Sleigh	Jacob Dutcher,	Gibson,	Penna.	24
Brake,—Wagon,	J. H. H. Bennett,	Hunt's Hollow,	N. Y.	24
———	H. W. Norville,	Livingston,	Ala.	24
Brakes,—Railroad	C. F. Langford,	Fall River,	Mass.	3
Bread,—Manufacture of	Benjamin Garvey,	City of	N. Y.	17
Brick Machines,	I. M. Gattman,	Cincinnati,	Ohio,	3
———	James Hotchkiss,	Yellow Springs,	"	17
Bridle Bits,	W. F. and W. R. Johnson,	Wetumpka,	Ala.	24
Broom,	Langdon & Weitman,	Hazleton,	Iowa,	17
——— or Brush,	J. H. Power,	Middletown,	"	10
Buckles,	S. S. Hartshorn,	New Haven,	Conn.	24
———	John Tiebout,	Brooklyn,	N. Y.	24

Burglar Alarm,	A. H. Enholm,	St. Louis,	Mo. 3
Butter Worker,	C. A. Boynton,	Hyde Park,	Vt. 17
Cables.—Surge-reliever for	James Bingham,	Philadelphia,	Penna. 24
Calendar,—Pocket	H. C. Foote,	McGaheysville,	Va. 17
Candles,—Apparatus for Mould'g	G. A. Stanley,	Cleveland,	Ohio, 31
Candlestick,	H. E. Rogers,	S. Manchester,	Conn. 24
Car Bodies with Trucks,	C. S. Moore,	Alexandria,	Va. 3
Carpet-sweeper,	Daniel Hess,	West Union,	Iowa, 10
Carriage Body,	Ernst Kirsch,	New Haven,	Conn. 31
——— Tops,—Movable	J. S. Belcher,	Albany,	N. Y. 10
Cartridge Case,	J. P. Lindsay,	City of	" 24
Cartridges,	B. B. Hotchkiss,	Sharon,	Conn. 10
———,—Packing	Christian Sharps,	Philadelphia,	Penna. 10
Casting,—Moulds for	S. A. Corser,	Northampton,	Mass. 10
Center-board Vessels,—Constr'n	Ketchum & Hunt,	Port Jefferson,	N. Y. 10
——— for Vessels,	Daniel G. Gerard,	Patchogue,	" 3
Chimney Cap,	T. J. Fitzpatrick,	New Orleans,	La. 24
Chimneys,	B. W. Taber,	Quaker Street,	N. Y. 24
Churn,	Levi Bissell,	N. Bergen,	" 10
———	N. B. Cooper,	Gratis,	Ohio, 3
———	John Raff,	Eden,	N. Y. 17
———	John Park,	Joliet,	Ill. 31
———	Sherman & Fenwick,	Union Town,	Md. 31
Clap-boarding Gage,	H. D. Vandercook,	Marshall,	Mich. 17
Clothes-frame,	C. A. Boynton,	Hyde Park,	Vt. 3
———	C. J. Ferguson,	City of	N. Y. 17
———	Asa Greenwood,	Toulon,	Ill. 17
———	Wm. Hathaway,	Providence,	R. I. 3
Clocks,—Pendulum	G. M. Phelps,	Troy,	N. Y. 10
Cocks,	Barton Pickering,	Dayton,	Ohio, 24
Coffee Pots,	John Denley,	Warsaw,	Ill. 24
———	George Neilson,	Boston,	Mass. 24
Condensing Apparatus,	G. S. G. Spence,	"	" 31
Condensers,	A. C. Brown,	Philadelphia,	Penna. 10
Copper Vessels,—Planishing	H. Kay & T. Avery, Jr.,	Brooklyn,	N. Y. 17
Corn Planters,	Samuel Avery,	Pisgah,	Mo. 10
———	F. A. Goddard,	Lexington,	Ill. 31
———	John Price,	Harrison,	Ohio, 10
———	Christopher Smith,	Nauvoo,	Ill. 31
—— Shellers,	T. J. Newland,	Wolcott,	Vt. 17
—— Stalks,—Shocking	S. B. Lawrence,	Hookstown,	Penna. 24
Cotton Bale Fastenings,	T. McIntire,	Franklin Furn.	Ohio, 17
—— ——— Ties,	Z. W. and E. D. Lee,	Blakely,	Ga. 3
——— Pickers,	John Griffin,	Louisville,	Ky. 3
———	Lewis Jennings,	Brooklyn,	N. Y. 31
——— Seed Hullers,	P. Martin,	New Orleans,	La. 31
——— Planters,	Zina Doolittle,	Perry,	Ga. 10
Couplings,—Car	J. P. Mendenhall,	Farmington,	Ill. 31
———	I. W. Van Houten,	Philadelphia,	Penna. 3
——— for City R. R. Cars,	Collyer & Patterson,	"	" 17
——— R. R. Cars,	Otis Hood, Jr.,	Turner,	Me. 17
———	Thorp & Shurtleff,	"	" 17
——— of Thills for Axles,	John McDermott,	Washington,	D. C. 24
———	Robert Morrison,	Rahway,	N. J. 24
———	James Sadler,	Egremont,	Mass. 24
Cracker Machine,	Cyrus Marsh, 2d,	Natchez,	Miss. 24
Cranes,	J. T. Smith,	Portsmouth,	Va. 10
Cultivators,	Agnew & Morrison,	Chadd's Ford,	Penna. 10
———	Ephraim Briggs,	Medina,	Ohio, 17
———	Council Clark,	Andersonville,	Ga. 3
———	Ezra Emmert,	Franklin Grove,	Ill. 31
———	Z. W. and E. D. Lee,	Blakely,	Ga. 31

Cultivators, .	J. B. Livezey, .	Clarksboro',	N. H.	10
——— .	Lostutter & Wolcott,	Rising Sun,	Ind.	31
——— .	Harrison Ogborn, .	Greenfork,	"	10
———,—Cotton .	T. H. Dodge, .	Washington,	D. C.	17
———————	Richard J. Gatling, .	Indianapolis,	Ind.	3
——————— .	J. A. Hartsfield,	Kinston,	N. C.	17
———————	Hinman & French, .	Watertown,	Mass.	10
——————— .	Rigell & Ivey, .	Dawson,	Ga.	17
———————	Jesse Speer, .	Hazlehurst,	Mass.	31
——————— .	G. W. N. Yost, .	Yellow Springs,	Ohio,	17
Curtain Fixture, .	Wm. Cleveland, .	City of	N. Y.	24
Cylinders,—Turning .	Gideon Sibley, .	Troy,	"	3
Distilling,—Appa's for boiling &	Wm. Hoffmire, .	San Francisco,	Cal.	31
——— Sea-water,—Appa's for	G. S. G. Spencer,	Boston,	Mass.	3
Ditching Machine,—Mole	Josiah Hodgson, .	N. Michigan,	Ill.	24
Door Plate,—Index .	Nathan Ames, .	Saugus Center,	Mass.	31
Dough,—Rollers for Pressing	Rice & Hayward, .	Providence,	R. I.	3
Dovetailing Machines,—Cutters	John Bell, .	Harlem,	N. Y.	10
Drain Tiles, .	E. W. Rowe, .	Brewer,	Me.	3
Dredging Apparatus, .	T. A Bryan, .	Queenstown,	Md.	6
Drills,—Ratchet .	L. R. Billard, .	Norfolk,	Va.	31
——,—Rock .	Cushman & French,	N. Bloomfield,	Cal.	3
Drilling Machines,—Rock	Francis Schwalm, .	Joliet,	Ill.	3
Engraving Copper Cylinders,	B. L. Philips, .	Providence,	R. I.	3
Excavating Machines,	G. S. Manning, .	Springfield,	Ill.	17
——— & Grading Machine,	P. T. Mayne, .	Keosauqua,	Iowa,	17
Fan Blowers, .	Henry Sweetapple, .	Napa,	Cal.	31
Fares,—Machine for Registering	M. W. Helton, .	Bloomington,	Ind.	24
Fats,—Machines for Cutting	W. E. Boulger, .	Janesville,	Wis.	3
——,—Appa's for Rendering	Tompert & Coyle,	Louisville,	Ky.	3
Faucets, .	James Flattery, .	Brooklyn,	N. Y.	24
Felly Machine, .	F. W. Mallett, .	New Haven,	Conn.	17
Fence Posts,—Socket for	Blood & Miller, .	Newport,	N. H.	3
——— Rails,— .	Christian Yost, .	Intercourse,	Penna.	3
Fences,—Portable .	W. M. Wallace, .	Cameron,	Ill.	3
Files,—Machines for Cutting	Etienne Bernot, .	Paris,	France,	24
———————	J. C. Cook, .	Middletown,	Conn.	10
Filters, .	John Fitch, .	Seneca Falls,	N Y.	10
Fire,—Protecting Buildings	S. M. Andrus, .	Bellevue,	Mich.	10
Fire Arms,—Breech-loading	M. J Gallager, .	Savannah,	Ga.	17
———————	R. F. Cook, .	Potsdam,	N. Y.	24
———,—Revolving	Ethan Allen, .	Worcester,	Mass.	3
———————	C. R Alsop, .	Middletown,	Conn.	17
———————	A. J. Gibson, .	Worcester,	Mass.	10
Fire-place and Chimney,	Daniel Hemingway, .	Covington,	Ky.	17
Fire Pokers, .	G. R Moore, .	Pittsburgh,	Penna.	24
Flour Chest, .	I. R. Shank, .	Buffalo,	Va.	24
Flower Stands, .	H. J. Coster, .	Chicago,	Ill.	17
Fluting Apparatus, .	G. B. Arnold & others,	City of	N. Y.	24
Fly Trap, .	H. H. Robertson,	Kingston,	Mo.	3
Food,—Preserving .	W. A. Keeler, .	City of	N. Y.	31
Foot-cleaner, .	Shaler & Rogers,	Madison,	Conn.	31
Fruit-drying Apparatuses,	A. C. Lewis, .	Burlington,	Mich.	31
Friction Wires,—Making	D. J. Ferry, .	Philadelphia,	Penna.	24
Furnaces,—Air .	Keller & Young, .	Cincinnati,	Ohio,	17
———,—Hot-air	Ernst & Shepard,	Milwaukie,	Wis.	17
Garments,—Fastening for	C. W. Baldwin, .	Boston,	Mass.	3
Gas,—Apparatus for Generating	Alexander Schwaninger,	Milwaukie,	Wis.	24
—— Generators, .	C. N. Tyler, .	Washington,	D. C.	24
—— Meters, .	John Schatt, .	Philadelphia,	Penna.	24

Gas Pipes,	Wm. Stephenson,	Galion,	Ohio,	10
—— and Water Pipe Joint,	C. W. Isbell,	New Haven,	Conn.	24
—— Regulators,	Thos. & Chas. Champion,	Washington,	D. C.	24
———— for R. R. Cars,	A. H. Phillippi,	Reading,	Penna.	31
—— Tubes,—Flexible Joints	Anthony Stratton,	Brooklyn,	N. Y.	10
Gates,	G. E. Baker,	Waukegan,	Ill.	24
Gear of Vehicles,	Richard Murdoch,	Baltimore,	Md.	10
Glass,—Manufacture of	Horace Trumbull,	Jersey City,	N. J.	3
—— Furnaces,	J. B. Hay,	Winslow,	"	24
—— Goblets,—Moulds for	A. J. Sweeney,	Wheeling,	Va.	3
Globes,	James Monteith,	City of	N. Y.	24
——,—School,	J. R. Agnew,	Philadelphia,	Penna.	24
————,—Suspending	James Monteith,	City of	N. Y.	24
Grain Binders,	J. S. Hickey,	Pike,	Ill.	17
————	Thomas Courser,	Princeton,	"	10
—— Cradles,	E. D. Wilcox,	Billingham,	Mass.	24
—— Separators,	George Arrowsmith,	Lockport,	N. Y.	10
————	Cornelius Bergen,	Farmer,	"	31
————	Thomas Earhart,	Donelson,	Tenn.	24
————	John C. Gregg,	Hillsboro',	Ohio,	17
————	A. J. Vandergrift,	St. Louis,	Mo.	24
————,—Governor	L. D. Lane,	Freeport,	Ill.	17
——,—Scouring & Separat'g	Matthew Bartholomew,	Enterprise,	Penna.	24
——,—Threshing & Cleaning	Ira Hart,	Clarksburg,	Va.	31
—— Winnowing Machines,	Bean & Wright,	Hudson,	Mich.	24
Grate,—Furnace	C. F. Cory,	Lebanon,	Ill.	24
Grates,—Stove	D. H. Nation,	Albany,	N. Y.	24
——, —— and Furnace	John V. B. Carter,	"	"	24
Gridiron,	Brooks & Grover,	Rochester,	"	24
Grindstones,—Center for Shaft	David Hinman,	Berea,	Ohio,	31
Handle to Picks, &c.,	J. H Fisher,	Placerville,	Cal.	17
Harmoneons,	H. W. Smith,	Boston,	Mass.	3
Harness Buckle,	J. W. Covel,	Bangor,	Me.	31
Harrows,	L. C. Gillespie,	Denmark,	Tenn.	10
Harvesters,	C. B. Brinckerhoff,	Batavia,	N. Y.	10
————	B. A. Jenkins,	Whitewater,	Wis.	10
———— of corn & sugar-cane,	G. W. N. Yost,	Cincinnati,	Ohio,	10
Harvesting Machines,	J. N. Bowman,	Brockport,	N. Y.	10
————	J. H. Rible,	Somerset,	Ohio,	10
————	Wm. Wilmington,	Toledo,	"	3
Hat Bodies,—Forming	Platt & Wildman,	Danbury,	Conn.	31
—— Ventilators,	F. H. Bell,	Washington,	D. C.	10
Hay Racks for Carts,	H. R. Hawkins,	Akron,	Ohio,	10
——,—Teeth for Scattering	J. C. Stoddard,	Worcester,	Mass.	24
Hemp Brakes,	E. W. Lacy,	Oak Park,	Va.	31
Hides,—Preparing	A. D. Lufkin,	Cleveland,	Ohio,	31
Hinges,—Spring	Abram Acker,	Ramapo,	N. Y.	17
Hoisting Apparatuses,	John Lemman,	Cincinnati,	Ohio,	17
Hominy Machines,	John Gehr,	Clear Spring,	Md.	17
Hook,—Mousing	Hjalmar Wynblad,	W. Hoboken,	N. J.	3
Horse Collars,	C. J. Fisher,	Wawkou,	Iowa,	17
Horse-shoe Machine,	Joseph Desnos,	Troy,	N. Y.	31
Horses,—Shoeing	G. R. Stevens,	Clarksville,	Mo.	3
Horse-shoes,—Making	H. A. Wills,	Keeseville,	N. Y.	3
Horse-stalls,—Attachment of	D. S. Neal,	Lynn,	Mass.	24
Horses from Cribbing,	Bishop & Low,	Warren,	"	31
———— Fire,—Rescuing	Elisha French,	Braintree,	"	31
———— Vehicles,—Detach'g	A. B. Johnson & others,	Clarksville,	Mo.	3
————	J. M. Roberds,	Plaisance,	La.	24
Hot Water Apparatuses,	Henry Humphreyville, Jr.,	Strasburg,	Penna.	24
Ice-breaker,	C. W. Chapman,	Hartford,	Conn.	3
Ice-pick,	J. T. Van Kirk,	Philadelphia,	Penna.	17

Lamps,	James Adair,	Pittsburgh,	Penna.	31
———	Wm. Fulton,	Cranberry,	N. J.	24
———	Sumner Sargent,	Watertown,	Mass.	24
———	John Schley,	Savannah,	Ga.	24
———	I. W. Taber,	New Bedford,	Mass.	17
———	J. T. Van Kirk,	Philadelphia,	Penna.	17
——— for Locomotives,	James Radley,	City of	N. Y.	31
———,—Mica Chimney for	J. Y. Humphreys,	Philadelphia,	Penna.	17
———,—Vapor	Erastus Crooker,	Buffalo,	N. Y.	10
———————	I. Van Bunschoten	City of	"	31
Lathe,	Milton Roberts,	Worcester,	Mass.	10
Lath Machine,	R. J. Gatling,	Indianapolis,	Ind.	10
Leather,—Machs. for Crimping	Horace Wing,	Buffalo,	N. Y.	31
———,—Skiving	W. S. Williams,	Lynn,	Mass.	31
Lemon-squeezer,	L. S. Chichester,	City of	N. Y.	3
Lightning-rods,—Construction	J. M. Patterson,	Woodbury,	N. J.	31
Lights for Ships,—Side	Enoch Holden,	City of	N. Y.	10
———,—Street	J. H. Kalb,	Charleston,	S. C.	31
Lock,	C. E. Brown,	Bridgeport,	Conn.	10
Locks,—Door	Calvin Adams,	Pittsburgh,	Penna.	3
Locomotive Engines,—Exhaust	John Dykeman,	Greenbush,	N. Y.	3
Looms,	L. R. Wattles,	Newton,	Mass.	31
———,—Pattern Chain for	B. H. Jenks,	Philadelphia,	Penna.	24
Lubricating Compound,	Radspinner & Moss,	N. Richmond,	Ohio,	3
——————— Pistons,	Benjamin Garvey,	City of	N. Y.	17
——————— Purposes,—Compo.	C. Chitterling,	Dunkirk,	"	24
Mattress and Bed,	F. Elder,	Winnsboro',	S. C.	10
Meat-cutter,	Louis Bonnet,	City of	N. Y.	24
———————	J. G. Perry,	S. Kingston,	R. I.	31
Meat-cutters,—Cylinders for	S. R. Plumb,	Southington,	Conn.	31
Melodeons,	S. H. Jones,	Jamaica Plains,	Mass.	3
———————	C. J. Van Oeckelen,	City of	N. Y.	3
Mills,	Wm. Joslin,	Cleveland,	Ohio,	3
———	A. H. Wagner,	Staunton,	Va.	31
Mill Bushes,	J. G. Shafer,	Fulton co.,	Penna.	3
Mills,—Corn and Cob	S. A. Briggs,	Philadelphia,	"	3
Millstones,—Dressing	M. H. Bacon,	Mystic,	Conn.	10
———————	"	"	"	31
———————	G. Z. Hockenburry,	Pittsburgh,	Penna.	24
———————	Martin Shirk,	Lancaster co.,	"	24
Mills,—Grinding	Ruof, Heupel, & Leuthy,	"	"	3
Mop Head,	James Doty, Jr.,	West Falls,	N. Y.	17
Mortising Machine,	Eleazar Coffin,	Indianapolis,	Ind.	17
Motion to Machinery,—Transf.	Wm. Phelps,	Sycamore,	Ill.	3
Motive Power,	Towsley & Matteson,	City of	N. Y.	24
———————,—Obtaining	Jacob Pringle,	Summer Hill,	Penna.	24
———————,—Steam for	J. W. Durham,	Durhamville,	Tenn.	17
Mowing Machines,	A. B. Allen,	City of	N. Y.	24
———————	Frederic Gardiner,	Gardiner,	Me.	31
———————	J. W. Shipman,	Springfield Cen.	N. Y.	24
———————	F. W. Warner,	E. Haddam,	Conn.	31
Needle Threaders,—Casting	S. S. Burlingame,	Warwick,	R. I.	24
Nail Brush,	Wm. Thomson,	Buffalo,	N. Y.	31
Odometers,	A. T. Howard,	Hartford,	Vt.	3
Oil Cans,	James Jackson, Jr.,	Westerly,	R. I.	31
——,—Distillation of Coal	Benjamin Garvey,	City of	N. Y.	17
—— Feeder,	Joshua Turner,	Cambridgeport,	Mass.	31
Oils,—Fish	Wm. D. Hall,	Hamden,	Conn.	17
Ordnance,—Projectiles for	B. B. Hotchkiss,	Sharon,	"	24
———,—Repeating	J. A. Matthews,	St. Louis,	Mo.	31

Ore Separator,	Samuel Man,	Chicago,	Ill.	31
———	E. L. Seymour,	City of	N. Y.	17
Paint Can,	J. W. Masury,	City of	N. Y.	10
Padlock,	Roos & Spoehr,	"	"	31
Paper Pulp,—Manufacture of	Ebenezer Clemo,	Toronto,	C. W.	10
Pawl and Ratchet,	E P. Russel,	Manlius,	N. Y.	24
Pegging Jacks,	Ephraim Everson,	Haverhill,	Mass.	24
———	E. L Harlow,	Monmouth,	Me.	31
Pen and Pencil Case,	G. E. Frew,	Brooklyn,	N. Y.	31
—— Holder,	Jonathan Warren,	"	"	31
Photographic Paper,—Silvering	Thompson & Wheaton,	City of	"	31
Piano-fortes,	J. U. Fischer,	"	"	10
———	G. H. Hulskamp,	Troy,	"	10
Piano-forte Action,	F. W. Niehaus,	Boston,	Mass.	3
Pianos,—Bridges for	Wm. Compton,	City of	N. Y.	10
——,—Tuning	J. B. Morris,	Berryville,	Va.	3
Picture Frames,—Enameling	John Sperry,	City of	N. Y.	10
Pins,—Manufacture of	T. and De G. Fowler,	Northford,	Conn.	31
Planing Machine,	Benaiah Fitts,	Worcester,	Mass.	31
———	W. N. Manning,	Salem,	"	17
Plotting Instrument,	Samuel Barnett,	Washington,	Ga.	17
Ploughs,	E. B. Clark,	Tallahassee,	Fla.	17
———	Wm. Griffin,	Bennettsville,	S. C.	3
———	Loure Green,	Great Bend,	Penna.	17
———	M. C. McCullers,	Herndon,	Ga.	17
———	H. H. Robertson,	Kingston,	Mo.	10
———,—Ditching	James Brooks,	Romulus,	N. Y.	31
———,—Capstans	Elias Forbes,	London,	Ohio,	24
———,—Gang	T. S. Heptinstall,	Mendota,	Ill.	17
———	J. C. Wilson,	Cedar Hill,	Texas,	3
———,—Mole	A. M. Karr,	Mt. Pleasant,	Iowa,	24
———	C. W. Stafford,	Burlington,	"	24
———,—Steam	T. H. Burridge,	St. Louis,	Mo.	31
Polishing Cabinet-work,	J. B. Morris,	Ansonia,	Conn.	24
Potatoes.—Covering	H. L. Bennett,	Long Branch,	N. J.	31
Potato-diggers,	G. C. Bartlett,	Paris,	N. Y.	24
———	Daniel De Garmo,	Rochester,	"	24
Potato-parer,	Charles Disston,	Philadelphia,	Penna.	3
Presses,—Cotton	Henry Mason,	Lancaster,	Mass.	24
———,——— and Hay	H. F. Hicks,	Grand View,	Ind.	24
———,—Hay	I S. Arnold,	South Milan,	"	3
———	S. G. Randall,	N. Britain,	Conn.	17
———	Sylvester Stevens,	Sacramento,	Cal.	24
Prisons,—Iron,	E. Jacobs,	Cincinnati,	Ohio,	24
Propellers,—Rocking	Edward Landis,	Baltimore,	Md.	24
Pumps,	Birdsill Holly,	Lockport,	Ill.	24
———	J. A. C. J. Smith,	Philadelphia,	Penna.	10
———	Chapman Warner,	Brooklyn,	N. Y.	31
——— for Locomotive Engines,	C. L. Rice,	Milwaukie,	Wis.	17
Punching Machines,	Bradshaw & Coley,	Lowell,	Mass.	24
———	Chas. Hughes,	N. Orleans,	La.	24
Quartz-crushing Apparatus,	Celestino Dominguez,	San Francisco,	Cal.	3
Railroad Bolts,—Fastening Nuts	G. W. R. Bayley,	Brashear,	La.	24
——— Cars,—Couches for	Wm. A. Brown,	Philadelphia,	Penna.	17
———,—Dumping	A. B. Cooley,	"	"	3
———,—Journal Box	Josiah Ashenfelder,	"	"	31
———,—Seal Lock for	J. H. Lyon,	City of	N. Y.	17
———,—Stop. & Start.	E. S. Ritchie,	Brookline,	Mass.	3
——— Cattle Car,	J. B. Shafer,	Grafton,	Va.	31
——— Gates,	Lester Butler,	Kenosha,	Wis.	17
———	McNair & Elliott,	Augusta co.,	Va.	17

Railroad Switches,	J. C. Whitson,	Marion,	N. C.	17
Rakes,—Horse	Wm. & Thos. Schnebly,	Hackensack,	N. J.	10
———	Seidle & Eberly,	Mechanicsb'gh,	Penna.	3
———,—Horse Hay	A. R. Hurst,	Chambersburg,	"	10
Rat Traps,	Leonard Parker,	Winterset,	Iowa,	17
Refrigerator,	W. W. Stannard,	Buffalo,	N. Y.	31
Register Point,	J. W. Cliff,	Rochester,	"	31
Roofing, Belting, &c.,—Fabric	J. B. Wands,	Memphis,	Tenn.	31
——— and Cement,—Comp.	Alexander Asboth,	City of	N. Y.	3
Rotary Engines,	S. T. Russell,	Ottawa,	Ill.	31
Sash-fastener,	T. L. Braynard,	City of	N. Y.	24
———	Julius Hornig,	Newark,	N. J.	24
Sash Stops to Windows,	N. L. McFarlan,	Syracuse,	N. Y.	3
Sausage-stuffer,	Jacob Kinzer,	Pittsburgh,	Penna.	31
Sawing Bevels on Laths,	G. W. Corson,	Corson's P. O.	"	10
——— Boards,—Machine for	Timothy Drake,	Windsor,	Conn.	3
——— Machine,	Carey Pitts,	Troy,	N. Y.	3
———,—S'm cross-cut	S. M. King,	Lancaster,	Penna.	31
——— Staves,—Machine for	H. H. Evarts,	Chicago,	Ill.	10
———	W. W. and J. B. Hurlbut,	"	"	3
Saws,—Straining Scroll	Chas. Rose,	Allentown,	Penna.	3
Saw-mills,	G. H. Clemens,	Cincinnati,	Ohio,	10
Staves,—Machine for Jointing	J. F. & I. W. Bristow,	Vevay,	Ind.	3
Scaffolds,—Supporting	J. K. Lewis,	Rising Sun,	"	10
Scissors,	J. G. DeCoursey,	Philadelphia,	Penna.	24
Screw Wrenches,—Heading	L. and A. G. Coes,	Worcester,	Mass.	31
Screws,—Making	Justus Griggs,	Utica,	N. Y.	31
Seed Planters,	G. T. Bennett,	Mt. Olive,	N. C.	17
———	George Hetrick,	Reidsburg,	Penna.	10
Seeding Machines,	G. W. Clark,	Mt. Washington	Ohio,	10
———	Ezra Emmert,	Franklin Grove,	Ill.	10
———	J. S. Gage,	Dowagiac,	Mich.	10
———	Hermann Kaller,	Perry,	Ill.	17
———	W. P. Penn,	Belleville,	"	17
———	Edwin Ritson,	Sanbornton,	N. H.	10
———	D. J. Vail,	Industry,	Ill.	31
Segars,	Isaac Lindsley,	Providence,	R. I.	31
Sewing Machines,	Ezekiel Booth,	Troy,	N. Y.	3
———	John First,	City of	"	3
———	W. C. Hicks,	Boston,	Mass.	24
———	Hugo Mueller,	City of	N. Y.	3
———	J. S. McCurdy,	Brooklyn,	"	3
———	Penny & Botsford,	Wooster,	Ohio,	3
———	W. A. Sutton,	City of	N. Y.	17
———	C. H. Willcox,	"	"	31
———,—Shuttles	Planer & Siegl,	"	"	17
———,—Spool Pins	George Churchill,	Hartford,	Conn.	17
Ships Boats,—Lowering, &c.,	J. A. Davis,	Portsmouth,	Va.	10
—— Rigging,—Setting-up	E. U. Thompson,	Bristol,	Me.	17
Shoemakers Last,	J. C. Plumer,	Portland,	"	17
Shovels,	J. U. Fiester,	Winchester,	Ohio,	17
Signal Lantern,	T. F. Woodward,	S. Reading,	Mass.	10
Silk in the Hank,—Stretching	Lucius Dimock,	Hebron,	Conn.	17
Skates,	Jeremiah Heath,	Providence,	R. I.	3
———	L. and I. J. White,	Buffalo,	N. Y.	10
Smoothing-irons,—Heating	J. E. Johnson,	Brockport,	"	31
———,—Self-heating	B. O. Ball,	Greensburgh,	Ohio,	10
Smut Machines,	Drake & Hewett,	Marshall,	Mich.	31
———	Samuel Favinger,	Philadelphia,	Penna.	17
———	Richard Mohler,	Lancaster,	"	24
Soldering Irons,	Lester Patee,	Peoria,	Ill.	3
Springs,—Adjustable Carriage	George Palmer,	Littlestown,	Penna.	24

Springs,—Car .	McCormick & Jerrold,	Paterson,	N. J.	17
Spring,—Compensating Lever	Wm. S. Pratt, .	Williamsburgh,	N. Y.	24
Spoke Machine, .	S. B. Wilkins, .	Milton,	Penna.	10
Stamping Heads,—Casting	P. W. Gates, .	Chicago,	Ill.	31
Stave Machine, .	W. M. Sloan, .	Buffalo,	N. Y.	17
Stave-jointing Machines,	C. M. Young, .	Sinclairsville,	"	31
Steam Boilers, .	Bean & Collins,	Manchester,	N. H.	3
——— .	J. H. Boardman, .	City of	N. Y.	31
——— .	John Brown, .	"	"	24
——— .	Jonathan Vaile, .	Miami,	Ohio,	24
———,—Alarm Gauge	C. T. Pangborn,	Brooklyn,	N. Y.	24
———,—Feeding Appar.	Thomas Shaw, .	Philadelphia,	Penna.	31
———,—Fusible Plugs	I. C. Saunders, .	Trenton,	Mich.	24
———,—Low-water Det.	J. W. Hopper, .	City of	N. Y.	24
———,—Valves for	D. R. Prindle, .	E. Bethany,	"	3
——— Engines, .	W. Birkbeck, .	Jersey City,	N. J.	3
———,—Boiler-feeders	E. A. Wood, .	Utica,	N. Y.	3
———,—Governors for	Jerome Wheelock, .	Worcester,	Mass.	3
———,—Pumps for	J. F. Hamilton, .	Pittsburgh,	Penna.	24
——— Generator .	Benjamin Garvey, .	City of	N. Y.	17
——— Land Carriages,	C. H. Baker, .	Red Wing,	Minn.	3
——— Pressure Gauge, .	Wm. P. Parrott, .	Boston,	Mass.	24
Steering Apparatus.	E. W. Tarbell, .	"	"	31
——— Vessels,—Mode of	F. E. Sickles, .	City of	N. Y.	17
Stereotype Plates,—Making	S. H. Mix, .	Schoharie,	"	10
Stone-dressing Machines,	Francis Schwalm, .	Joliet,	Ill.	10
Stone,—Machine for Crushing	G. A. Rollins, .	Nashua,	N. H.	17
Stoves, .	Charles Jones, .	Philadelphia,	Penna.	17
——— .	S. H. Ransom, .	Albany,	N. Y.	24
———,—Coal .	Lucius Crandall, .	Plainfield,	N. J.	24
———,—Cooking	Cavanaugh & Lazear,	Jersey City,	"	24
——— .	Johnson & Wansbraugh,	Cincinnati,	Ohio,	31
Stove-pipes,—Machine for Form.	James Rogers, .	Sa. Clara co.,	Cal.	31
Straw Cutters, .	Samuel Ring, .	Cleveland,	Ohio,	24
——— and Stalk Cutters,	Preston, Jr., & Farnham,	Corning,	N. Y.	31
Submarine Operator, .	G. W. Martin, .	W. Morrisania,	"	24
Sugar,—Appar. for Draining	J. J. Unbehagen,	Baton Rouge,	La.	10
——— Cane,— Wind-rowing	B. A. Jenkins, .	Whitewater,	Wis.	3
——— Kettle Trains,	J. P. Henderson,	Franklin,	La.	10
Surveyors Tackle Case, .	W. H. Paine, .	Sheboygan,	Wis.	10
Sweeping Streets,—Machine for	G. M. Ramsay, .	City of	N. Y.	10
Switch Plates for City R. R.s,	Wm. Ebbitt, .	"	"	24
Syringes, .	Benjamin Irving,	"	"	10
——— .	E. G. Stevens, .	Biddeford,	Me.	10
Tanning,—Compounds for	D. J. Cochran, .	Centerville,	Ind.	17
——— Extracts, .	James Connell, .	Port Huron,	Mich.	17
Telegraphic Repeaters,	J. J. Clark, .	Philadelphia,	Penna.	24
Thills to Vehicles,—Attaching	L. C. Miner, .	Hartford,	Conn.	17
Thread-polishing Machines,	L. C Ives, .	"	"	17
Threshing Machines, .	W. W. Dingee, .	York,	Penna.	24
———	S. E. Oviatt, .	Richfield,	Ohio,	10
——— Peas and Beans,	J. T. Smith, .	Portsmouth,	Va.	24
Timber,—Comp. for Preservation	John Dain, .	Utica,	Ohio,	31
Tobacco Boxes, .	Friedrick & Walter, .	City of	N. Y.	17
——— .	Henry Kurth & others,	Brooklyn,	"	31
———,—Pressing .	John Henry, .	Lynchburgh,	Va.	24
Tool Sharpener,—Edge	S. W. Wood, .	Watertown,	N. Y.	24
Trees,—Machine for Felling	A. P. Torrence, .	Oxford,	Ga.	3
—— from Insects,—Protecting	Nathaniel Potter, Jr.,	S. Dartmouth,	Mass.	10
Trusses, .	Henry Dalton, .	City of	N. Y.	3
———,—Belt .	J. C. Rainbow, .	New Brighton,	Penna.	31
———,—Hernial Spring	D. L. D. Sheldon, .	San Francisco,	Cal.	31

Tubes,—Aesophagus,	N. Q. Munger,	Brookfield cen.	Wis.	10
——,—Forming Seamless	C. E. L. Holmes,	Waterbury,	Conn.	24
Tweers,	Tolman & Blodget,	N. Orange,	Mass.	10
Type-metal with Brass,—Coat'g	Joseph Corduan,	Brooklyn,	N. Y.	17
Varnish,—Polishing	Bennett & Stover,	Boston,	Mass.	3
Vermin,—Appar. for Destroying	Levi Disbrow,	Oswego,	N. Y.	31
Vinegar,—Manufacture of	F. M. Ruschhaupt,	City of	"	31
Warming Apparatus,	J. H. Davis,	Woburn,	Mass.	31
Washing Machine,	John Contrell,	City of	N. Y.	10
———	Wm. Gowen	Wausau,	Wis.	17
———	A. B. Harlan,	Ercildoun,	Penna.	17
———	S. T. Vallett,	Providence,	R. I.	3
Watches,	O. H. Woodworth,	Coffeeville,	Miss.	17
Watch Chains,—Hooks for	J. R. Lounsberry,	N. Eng. Village,	Mass.	10
Watchmakers Lathes,	Albert Wild,	City of	N. Y.	17
Water Closet,—Portable	Enoch Hidden,	"	"	24
Water,—Method of Cooling	Thomas Byrne,	Baton Rouge,	La.	10
——— Metres,	Gerard Sickles,	Roxbury,	Mass.	24
——— Pipes to Buildings,	Wm. Austin,	Philadelphia,	Penna.	3
——— Wheels,	Closs & Pyle,	Decatur,	Ind.	10
———	Henry Fellows,	Bloomfield,	"	24
———	James Martin,	Florence,	Ala.	3
———	J. M. Perkins,	Chicago,	Ill.	24
———	J. W. Truax,	Richford,	Vt.	24
Wheels,—Adjusting Tire on	W. S. Harrison,	Carson's Land.	Miss.	3
——— for Gun Carriages, &c.,	C. F. Brown,	Warren,	R. I.	10
Whiffle-trees for Vehicles,	Ignaz Ramminger,	City of	N. Y.	17
Windmills,	Arnold De Witt,	Brooklyn	"	3
———	Henry Glover,	E. Douglas,	Mass.	10
Windows,—Appar. for Cleaning	George Munce,	St. Louis,	Mo.	31
Window Sashes,—Elevator for	Samuel Mills,	City of	N. Y.	31
——— Stop and Fastening,	Turner Williams,	Providence,	R. I.	17
Wrench,	R. P. Buttles,	Mansfield,	Penna.	3
Yokes,—Bow of Ox	Warren & Silliman,	Chester,	Conn.	17

EXTENSIONS.

Horse-powers,	Sheldon & Cary,	Chili,	N. Y.	3
Looms,	W. D. Dutcher,	Milford,	Mass.	3
Netting Machines,	John McMullen,	Baltimore,	Md.	3

ADDITIONAL IMPROVEMENTS.

Altitudes of the Sun,—Taking	Frederick Yeiser,	Indianapolis,	Ind.	17
Clover Hullers,	Anthony Overocker	McHenry,	Ill.	24
Grates,	Joseph Tiberi,	St. Louis,	Mo.	17
Railroad Cars,—Roofs for	A. P. Winslow,	Cleveland,	Ohio,	31
Shoe Heels,—Cutting & Finish.	W. F. Edson,	Philadelphia,	Penna.	24

RE-ISSUES.

Air Engines,	Philander Shaw,	Boston,	Mass.	17
Artificial Legs,	Douglas Bly,	Rochester,	N. Y.	3
Bedsteads,—Folding	T. B. Bleecker,	City of	"	24
Canal Boats,—Paddle Wheels	Reuben Jane,	Otego,	"	3
Fences,—Panels of Portable	Chas. Van DeMark,	Oak Corners,	"	10
Gas Regulators,	Salmon Bidwell,	City of	N. Y.	31
Grain Separators & Cleaners,	W. M. Arnall,	Sperryville,	Va.	10
———,—Shoe for	Hiram Aldridge,	Michigan City,	Ind.	31
Harvesters and Binders (2 pats.),	H. Baldwin, Jr.,	Washington,	D. C.	3
Mowing Machines (7 patents),	Ephraim Ball,	Canton,	Ohio,	17
Oilcloth,—Printing 2 "	James Albro,	Elizabeth,	N. J.	3
Paper Pulp,—Manu. 2 "	Palser & Howland,	Ft. Edward,	N. Y.	3
Photo-lithography,	Cutting & Bradford,	Boston,	Mass.	31

Printing Presses (2 patents),	G. P. Gordon,	City of	N. Y.	31
Reaping Machines, 3 "	W. H. Seymour,	Brockport,	"	10
Saw-mills—Circular	N. G. Norcross,	Lowell,	Mass.	10
Seeding Machines,	A. E. Bonham,	Elizabethtown,	Ohio,	10
Steam Boilers,—Feed-water	G. W. Rains,	Newburgh,	N. Y.	24
Windlasses,—Ships	Wm. H. Gilmore,	Worcester,	Mass.	31

DESIGNS.

Gridiron,	Elnathan Peck,	New Britain,	Conn.	17
Hub Bands,	B. S. Pardee,	Mt. Carmel,	"	31
Range,—Cooking	Sanders & Vedder,	City of	N. Y.	31
Spoon Handles,	H. C. Foster,	Worcester,	Mass.	3
Stove,	Isaac DeZouche,	St. Louis,	Mo.	3
——,—Coal	Daniel Hathaway,	Troy,	N. Y.	31
——,—Cook's	W. W. Stanard,	Buffalo,	"	24
——— (4 patents),	G. Smith & H. Brown,	Philadelphia,	Penna.	3
——,—Cooking (2 cases)	S. H. Ransom,	Albany,	N. Y.	3
——— "	W. W. Stanard,	Buffalo,	"	31
——— "	G. Smith & H. Brown,	Philadelphia,	Penna.	3
———	N. S. Vedder,	Troy,	N. Y.	31
——,—Parlor	S. H. Ransom,	Albany,	"	3
———	W. W. Stanard,	Buffalo,	"	31
——,—Six-plate	Daniel Hathaway,	Troy,	"	31
——,—Plates of a Cook's	G. Smith & H. Brown,	Philadelphia,	Penna.	17
Trade Mark,	D. L. Meineke,	St. Louis,	Mo.	31

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, September 20, 1860.

John C. Cresson, President, in the chair.

John Agnew, Vice-President,
Isaac B. Garrigues, Recording Secretary, } Present.

The minutes of the last meeting were read and approved.

Donations to the Library were received from la Société Industrielle de Mulhouse, France; the Hon. P. F. Thomas, Commissioner of Patents, and Frederick Emerick, Esq., Washington, D. C.; the Massachusetts Charitable Mechanics Association, Boston, Mass.; Thomas Ewbank, Esq., and Dr. Martyn Paine, City of New York; the Wilmington Institute, and Edward Tatnell, Esq., Wilmington, Del.; the Maryland Institute, Baltimore, Md.; John A. Roebling, Esq., Trenton, N. J.; Dr. Charles M. Wetherill, Lafayette, Ind.; the Harrisburgh, Portsmouth, Mountjoy, and Lancaster Railroad Co., Messrs. Moses Thomas & Sons, and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of August was read.

The Board of Managers and Standing Committees reported their minutes.

Candidates for membership in the Institute (9) were proposed, and the candidates proposed at the last meeting (12) duly elected.

Mr. Howson exhibited a collection of fire arms manufactured by

Christian Sharps, Esq., (the well-known inventor of Sharps' rifle,) at his establishment in West Philadelphia.

The first arm exhibited was a specimen of the standard military carbine, arranged to load at the breech, and having the patent self-priming device. This arm was manufactured in New England from Mr. Sharps' designs, and is, in most respects, similar to those made for the United States, as well as for several European governments. It has, however, an improvement in the self-priming arrangement, whereby the magazine of caps may be reserved for emergencies, and caps of ordinary construction used.

Two beautiful specimens of light breech-loading rifles with barrels of smaller calibre than the above were next exhibited. These were arranged to receive a metallic case containing the charge of powder and ball; the case after being discharged is withdrawn from the breech to be again used after it has received a new charge. A suitable number of these cases are carried in a pouch by the sportsman, who recharges them at his leisure.

Several specimens of Sharps' patent breech-loading repeating pistol were exhibited and explained. This fire arm consists of a barrel block with four bores, the block being arranged to slide to and fro on the stock. A metallic cartridge is inserted into each bore, the block moved up to the stationary breech of the stock and there locked, when the fire arm is ready for being discharged. The hammer is provided with a revolving nipple which strikes each cartridge in succession, the movement of the nipple being effected by the cocking of the hammer.

Mr. Howson exhibited the several pieces of which one of these pistols was composed, in their crude state, remarking that each piece was reduced to its proper form by machinery, with an exactitude which no manipulation could accomplish, every portion of one pistol being an exact counterpart of the corresponding portions of another pistol; and that when the extent and beauty of the workmanship is considered, it is almost impossible to conceive how these weapons can be manufactured so rapidly as to be retailed for the low price of ten to twelve dollars; but that a visit to Mr. Sharps' factory, and an examination of the beautiful and effective tools there used, and a knowledge of the fact that subdivision of labor is there carried out to perfection, would solve the mystery.

Vast quantities of these arms are sent to all parts of the Union by Messrs. Handy & Brenner, of this city, the sole agents for the sale of Sharps' fire arms.

Mr. H. subsequently explained to the meeting Mr. Sharps' improvements in the construction of metallic cartridges, which are destined to replace the ordinary paper cases. These cartridges, first used in France, consist of thin metal cases, with an enlargement at one end for containing the detonating material, and a bullet at the opposite end; the interior of the case containing the charge of powder, and the cartridges being exploded by causing the hammer to strike the edge of the enlargement.

It is necessary, in order that the spent cartridges may be readily

extracted from the bore of the barrel, that the cases should have a slight taper. In order to impart this taper to, and to form the enlargement on, a hollow metal cylinder closed at one end, Mr. Sharps uses a die composed of two steel blocks, in which is formed a chamber of the shape of the desired case. Into this chamber is dropped the hollow cylinder, the latter being subsequently partially filled with water. A plunger is now inserted into the mouth of the cylinder, and a smart blow imparted to it, thereby causing the metal to expand and adapt itself to the shape of the chamber; after which the now completed case is withdrawn from the dies.

By this contrivance, and others of equal simplicity and ingenuity for spreading the detonating material in the enlargement of the case and confining it therein, Mr. Sharps is enabled to make the most perfect metallic cartridges at the same cost as those made of paper.

It was remarked, in conclusion, that Mr. Sharps had devoted the greater part of his life to the experimenting with and the designing of improvements in fire arms and projectiles, and this with such success, that the superiority of his ware was universally acknowledged: many European regiments being armed with the celebrated Sharps' rifle.

Mr. Thomas E. McNeill exhibited a very beautiful and ingenious steam gauge invented and patented by Mr. J. E. Wootten. It consists of a steam chamber formed by riveting together at their edges two disks of very hard rolled sheet brass. The dilation of these disks under pressure, communicates motion to the index pointer, by means of a coarse threaded screw cut upon the spindle to which the pointer is attached. A hair spring is attached to the spindle for the purpose of keeping its point at all times in contact with the front disk, by which means, an accurate indication of pressure is obtained.

BIBLIOGRAPHICAL NOTICE.

The Manufacture of Vinegar: its Theory and Practice; with especial reference to the quick process. By CHAS. M. WETHERILL, Ph. D., M. D. Philadelphia: Lindsay & Blakiston, 1860. 12mo. pp. 300.

This is an excellent theoretical and practical treatise upon a subject which possesses great interest for every one, especially to those who, living at a distance from manufacturing centres, are here shown how easily and with how little expenditure of capital they may ensure for themselves purity and proper strength of an article of such domestic importance. But the book has another and perhaps higher value, as a type of what such a treatise should be; the clear precise statement of its facts, its logical method, and absence of all parade of unnecessary learning, are the exact qualifications which are necessary to make a treatise on the manufacture of any speciality useful and interesting; and if more of those who have heretofore professed to write such treatises had attended to this, we should have had our

manufacturers and people much better informed upon such subjects than they now are.

We need not say to any one who reads this book, that its author is an excellent chemist; that is manifest as well by what he does not say as by what he does; but we take the opportunity of acknowledging the receipt of another investigation by him on the subject of the relative cost of light from different materials, which will be of great importance for the region of country in which he resides.

The book under consideration is very excellently got out by the well-known publishers, and is worthy of being read by all, and of being studied by all who are in any way interested in the manufacture of vinegar. F.

METEOROLOGY.

For the Journal of the Franklin Institute.

The Meteorology of Philadelphia. By JAMES A. KIRKPATRICK, A.M.

AUGUST.—The temperature of the month of August was a degree and a half below that of July last, about one degree above that of August, 1859, and about half a degree above the average temperature of August for the last ten years. It will be seen, by the table of comparisons given below, that this difference of temperature occurred principally at 2 o'clock in the afternoon, the means for 7 A. M. and 9 P. M., for 1860, being almost identical with those for the same hours for ten years; while the mean for 2 P. M., in 1860, was two degrees higher than the average for the same time.

The warmest day was the 5th, of which the mean temperature was 83°. The highest degree indicated by the thermometer was 95° on the 10th of the month; the mean temperature of that day was 82·7°. From the 4th till the 10th, the temperature did not fall below 70°, night or day. On the night of the 10th, however, rain fell, the wind changed from the south-west to the north-west, and, during the next day, the thermometer indicated an average fall of nearly 12°.

On the 13th a thunder-storm occurred. Rain fell in heavy showers all the morning; but about two o'clock in the afternoon the lightning became very vivid and the rain came down in torrents. In two hours, from two till four o'clock, three inches and thirty-five one-hundredths of an inch of rain fell—about four times as much as fell during the whole of the month of July. During the storm, a man was instantaneously killed by lightning in the southern part of the city. The rain continued heavy and steady until 11½ A. M., on the morning of the 14th.

The 14th was the coldest day of the month, the average temperature being 65°. The lowest degree indicated by the thermometer was 55° on the morning of the 15th.

The barometer was highest on the 16th, when it indicated a pressure equal to 30·026 inches; and lowest on the 25th, when it marked 29·632 inches. The average height of the barometer for the month

was very nearly the same as for August, 1859, and but three-hundredths of an inch lower than the average for the last ten years.

On the 23d, a very heavy rain-storm passed over the northern portion of the city. It is said that, at Manayunk, over ten inches of rain fell; while, in the centre of the city, less than two-tenths of an inch was collected in the rain-gauge.

The whole amount of rain that fell during the month was nine inches and twenty-six hundredths of an inch, which is a greater quantity than has fallen in the month of August for ten years. The nearest approach to it was in August, 1857, when a little over eight inches (8·039) fell. The average amount for this month is 4·714 inches.

There were five days of the month entirely clear, and two on which the sky was completely covered with clouds at the hours of observation.

A Comparison of some of the Meteorological Phenomena of August, 1860, with those of August, 1859, and of the same month for ten years, at Philadelphia.

	Aug., 1860.	Aug., 1859.	Aug., 10 years.
Thermometer.—Highest,	95°	97°	97°
" Lowest,	55	51½	47
" Daily oscillation,	18·80	20·50	15·90
" Mean daily range,	3·80	3·10	3·80
" Means at 7 A. M.,	70·13	69·03	70·29
" " 2 P. M.,	82·87	82·16	80·74
" " 9 P. M.,	73·29	72·39	73·37
" " for the month,	75·43	74·53	74·80
Barometer.—Highest,	30·026 in.	29·998 in.	30·255 in.
" Lowest,	29·632	29·671	29·356
" Mean daily range,	·090	·070	·092
" Means at 7 A. M.,	29·848	29·847	29·879
" " 2 P. M.,	29·813	29·801	29·851
" " 9 P. M.,	29·834	29·832	29·869
" " for the month,	29·832	29·827	29·866
Force of Vapor.—Means at 7 A. M.,	·580 in.	·551 in.	·584 in.
" " " 2 P. M.,	·584	·551	·596
" " " 9 P. M.,	·603	·581	·613
Relative Humidity.—Means at 7 A. M.,	77 per ct.	75 per ct.	77 per ct.
" " " 2 P. M.,	52	50	56
" " " 9 P. M.,	73	72	74
Rain, amount in inches,	9·260	4·447	4·714
Number of days on which rain fell,	13	8	10
Prevailing winds,	N.80°54′W·150	S.26°34′E.·055	S.83°35′W·104

SUMMER.—The meteorological summer, consisting of the months of June, July, and August, was, during this year, distinguished by many interesting phenomena which have been particularly noticed in the reports for the separate months. The eclipse of the sun, the extraordinary meteor of the 20th of July, the heated wind storms of Kansas and throughout the South-West, the unusually great number

of thunder-storms, and the destructive tornados in several of the Western States, will make the summer of 1860 a memorable one. But few of these storms reached Philadelphia, and those that did reach us seem to have spent their fury to a great degree before their arrival.

The pressure of the atmosphere was considerably less than the average, as will be seen by reference to the table of comparisons.

The temperature was intermediate between that of the summer of 1859, and the average for the nine past summers, being about three-quarters of a degree above the former, and the same quantity below the latter.

The force of vapor and relative humidity were both below the average.

The rain was half an inch more than fell in last summer, but nearly an inch more than the general average for the season. More than three-fourths of it, however, fell in the month of August.

The number of days on which rain fell was 33, being one more than usual.

The prevailing winds during this summer came from a point a little north of west, while their average direction for nine years is about twice as far south of west.

A Comparison of the Summer *of* 1860, *with that of* 1859, *and of the same season for nine years, at Philadelphia.*

	Summer, 1860.	Summer, 1859.	Summer, for 9 years.
Thermometer.—Highest,	95·5°	97°	100·5°
" Lowest,	52·0	42·0	42·0
" Daily oscillation,	19·20	19·90	16·10
" Mean daily range,	4·33	4·60	4·10
" Means at 7 A. M.,	70·11	69·36	71·20
" " 2 P. M.,	81·71	80·53	81·43
" " 9 P. M.,	72·23	71·48	74·01
" " for the summer,	74·68	73·79	75·55
Barometer.—Highest,	30·123 in.	30·202 in.	30·281 in.
" Lowest,	29·243	29·520	29 182
" Mean daily range,	·097	·095	·094
" Means at 7 A. M.,	29·805	29·866	29·859
" " 2 P. M.,	29·769	29·825	29·828
" " 9 P. M.,	29·789	29·848	29·844
" " for the summer,	29·788	29·847	29·844
Force of Vapor.—Means at 7 A. M.,	·529 in	·535 in.	·577 in.
" " " 2 P. M.,	·518	·555	·588
" " " 9 P. M.,	·547	·557	·607
Relative Humidity.—Means at 7 A. M.,	71 per ct.	72 per ct.	74 per ct.
" " " 2 P. M.,	48	52	55
" " " 9 P. M.,	68	71	71
Rain, amount in inches,	13·817 in.	13·591	12·979
Number of days on which rain fell,	33	31	32
Prevailing winds,	N.82°27′W·165	S. 73°8′W. ·182	S.74°27′W·159

Abstract of Meteorological Observations for July, 1860; made in Philadelphia, Franklin, Indiana, and Armstrong Counties, Pennsylvania, for the Committee on Meteorology of the Franklin Institute.

1860.	Philadelphia.—Lat. 39° 57′ 28″ N. Long. 75° 10′ 28″ W. Height above the sea 50 feet. Prof. J. A. Kirkpatrick, Observer.									Chambersburg, Franklin Co. Lat. 39° 58′ N. Long. 77° 45′ W. Height 618 ft. Wm. Heyser, Jr., Obs.							Indiana, Indiana Co. 40° 40′ N. 79° 10′ W. Height, 1321 ft. W. B. Hildebrand, Obs.				Freeport, Armstrong Co. 40° 44′ N. 79° 42′ W. Height 1000 feet. J. H. Baird, Obs.		
	Barometer.		Thermometer.			Force of vapor.	Relative humidity.			Barom.	Thermom.		Force of vapor.	Relative humidity.			Thermom.				Thermometer.		
July.	Mean.	Mean daily range	Mean.	Daily oscillation.	Mean daily range.	2 P.M.	2 P.M.	Rain.	Prevail'g winds.	Mean.	Mean.	Mean daily range.	2 P.M.	2 P.M.	Rain.	Prevail'g winds.	Mean.	Mean daily range.	Rain.	Prevail'g winds.	Mean.	Mean daily range.	Prevailing winds.
	Inch.	Inch.	°	°	°	Inch.	Per ct	Inches.	Direc.	Inch.	°	°	Inch.	Per ct.	Inch.	Direc.	°	°	Inch.	Direc.	°	°	Direc.
1	29·817	·134	74·3	17	11·0	·288	29	0·005	N.	29·249	71·0	9·0	·564	80	0·557	S.	73·0	1·7		N W.	67·7	6·7	N W.
○ 2	29·867	·065	77·0	21	2·7	·463	40		N W.	29·284	73·0	8·0	·718	77	0·100	W.	73·0	2·0		N E.	69·3	5·3	?
3	29·808	·074	71·7	4	5·3	·634	78	0·113	(var.)	29·162	78·7	5·7	·832	71		W.	74·3	2·0		N E.	70·3	3·7	W.
4	29·652	·176	70·0	20	7·3	·743	58	0·308	(var.)	28·740	76·7	2·7	·860	79	0·200	W.			R.				W.
5	29·545	·087	78·7	24	4·7	·554	38		(var.)	28·913	78·0	4·7	·746	64		W.					74·0		(var.)
6	29·810	·265	64·2	14	14·5	·378	53		N E.	29·174	64·3	13·7	·403	67		(var.)	74·0			W.	62·0	12·0	E.
7	29·884	·078	69·5	19	5·3	·289	33		E N E.	29·270	67·3	3·0	·403	52		N E.	70·3	3·7		S E.	66·7	5·3	(var.)
8	29·732	·152	70 8	20	5·0	·481	47	0·018	S S W.	29·068	74·0	3·3	·527	57		(var.)	69·0	2·0		S E.	70·3	3·7	(var.)
9	29·675	·106	80·0	21	9·2	·595	44		S W.	29·143	77·3	6·7	·582	50		(var.)	74·0	5·0		E.	74·0	3·7	W.
10	29·818	·145	84·3	22½	4·3	·560	37		S W.	29·193	81·0	5·3	·555	41		S.	77.7	1·0		N E.	78·0	4·0	W.
◐ 11	29·902	·085	76·3	14	8·0	·417	38		N N W.	29·304	76·7	6·0	·598	58		(var.)	70·3	7·3		N E.	65·3	12·3	(var.)
12	29 917	·014	71·3	20	5·0	·321	32		N W	29·342	68·0	8·7	·371	49	0·215	(var.)	63·3	7·0		N E.	61·3	4·3	N.
13	29 933	·035	72·3	22	1·0	·355	36		(var.)	29·359	67·7	3·0	·358	46		N E.	67·7	4·3		N.	63·7	2·3	?
14	29·936	·019	75·3	23	4·0	·404	36		N E.	29·349	70·7	3·0	·356	38		(var.)	71·0	6·0		N.	71·3	7·7	W.
15	29·908	·038	78·8	26	3·5	·384	30		S W.	29·290	77·0	9·7	·512	45		W.	74·7	4·0		S W.	74·0	3·3	W.
16	29·752	·156	84·0	25½	5·2	·506	34		S W.	29·186	80·7	3·7	·543	42		W.	77·0	2·3		S W.	79·0	5·0	S W.
17	29 799	·088	81·0	18	3·7	·431	32		N W.	29·225	79·3	4·7	·531	44		W.	75·0	3·3		W.	71·7	7·3	N.
● 18	29·929	·129	79·0	25	2·7	·458	36		S E.	29·289	79·0	4·3	·644	52		(var.)	76·0	1·7		S W.	74·7	6·3	S.
19	29·812	·116	82·8	19	3·8	·672	49	0·006	S W.	29·237	80·0	5·0	·819	68	0·175	W.	78·0	2·0	0.280	S W.	74·0	2·0	(var.)
20	29·755	·057	87·7	22½	4·8	·675	41		N W.	29·187	83·3	4·0	·609	46		W.	76·0	2·0		S W.	79·7	5·0	?
21	29·579	·176	81·7	16	6·0	·657	51	0·084	S W.	29·002	81·3	3·3	·733	61	0·180	(var)	71·0	5·0	0·380	W.	72·0	7·7	W.
22	29·734	·155	76 2	15	5·5	·368	33		(var.)	29·134	73·0	11·3	·497	46		W.	68·3	2·7		N W.			?
23	29·588	·146	77·8	17	1·7	·571	48	0·119	W.	29·010	75·3	5·0	·588	55		W.	69.7	4·0	0.170	N W.	66·0		N W.
24	29·840	·252	71·7	21	6·2	·288	29		(var.)	29 254	70·0	5·0	·382	44		W.	67·3	2·3		W.	64·3	2·3	N W.
◑ 25	29·926	·085	75·5	24	3·8	·514	46		S W.	29·332	73·0	3·3	·574	58		W.	72·3	5·0		W.	69·0	4·7	N W.
26	29·851	·076	76 7	26	1·2	·756	67	0·014	(var.)	29·228	76·3	3·0	·447	40		W.	72·3	2·0		W.	76·0	7·0	W.
27	29·806	·098	76·2	20	1·8	·564	47	0·184	(var.)	29·253	76·3	3·7	·585	55	0·260	(var.)	73·3	5·7	0·160	N E.	68·3	7·7	N W.
28	29·936	·137	72·2	21½	4·0	·403	39		S E.	29·353	74·7	3·7	·650	59		(var.)	73·3	0·7		N E.	74·0	5·7	(var.)
29	29·782	·154	74·7	15½	3·5	·687	69		S E.	29·117	76 3	3·0	·8.9	78	0·247	E.	71·3	1·0	1·120	N W.	75·3	5·3	S W.
30	29·617	·168	81·8	16	7·2	·630	51		S E.	29·077	77·7	2·7	·690	t 3		E.	71·3	3·0		N W.	69·7	5·7	N W.
31	29· 629	·014	81·7	24	2·8	·616	44		S W.	29·106	75·0	2·7	·637	62		E.	68 3	3·7		N.	67·7	2·0	(var.)
Means	29·791	·112	76·9	20	5·0	·505	43	0·851	s70°w	29·186	75·2	5·2	·588	56	2·564	s79°w	72·2	3·3	2·110	n31°w	70·5	5·5	n 66½° w.